

AI-Native Context-Adaptive UI for in-car Infotainment Systems



UX Research | Generative UI

Problem

Modern car interfaces are becoming more complex, with more features packed into large digital displays. Today, each screen is manually designed for specific use cases, which makes the process slow, expensive, and difficult to scale as features grow. This traditional approach requires significant time, effort, and cost which often runs into millions while still resulting in rigid interfaces that cannot easily adapt to constantly changing driving conditions.

Solution

My work introduces one of the very first functional frameworks where AI generates the entire UI for infotainment system in real-time based on various contexts. It leverages Large Language Models (LLMs) to assemble pre-validated UI components, the system provides a personalized, context-aware experience without compromising automotive safety standards.

- Direct Implications:**
- Significant reduction in Design and Development costs
 - Ability to cover any edge-cases which may occur, by enabling use-case-less design
 - Meaningful & personalised UX in real-time

My Role

This project spanned design, concept development, and implementation. I was responsible for driving the work end-to-end, combining UX research and design with system architecture and development to turn the idea into a working solution.

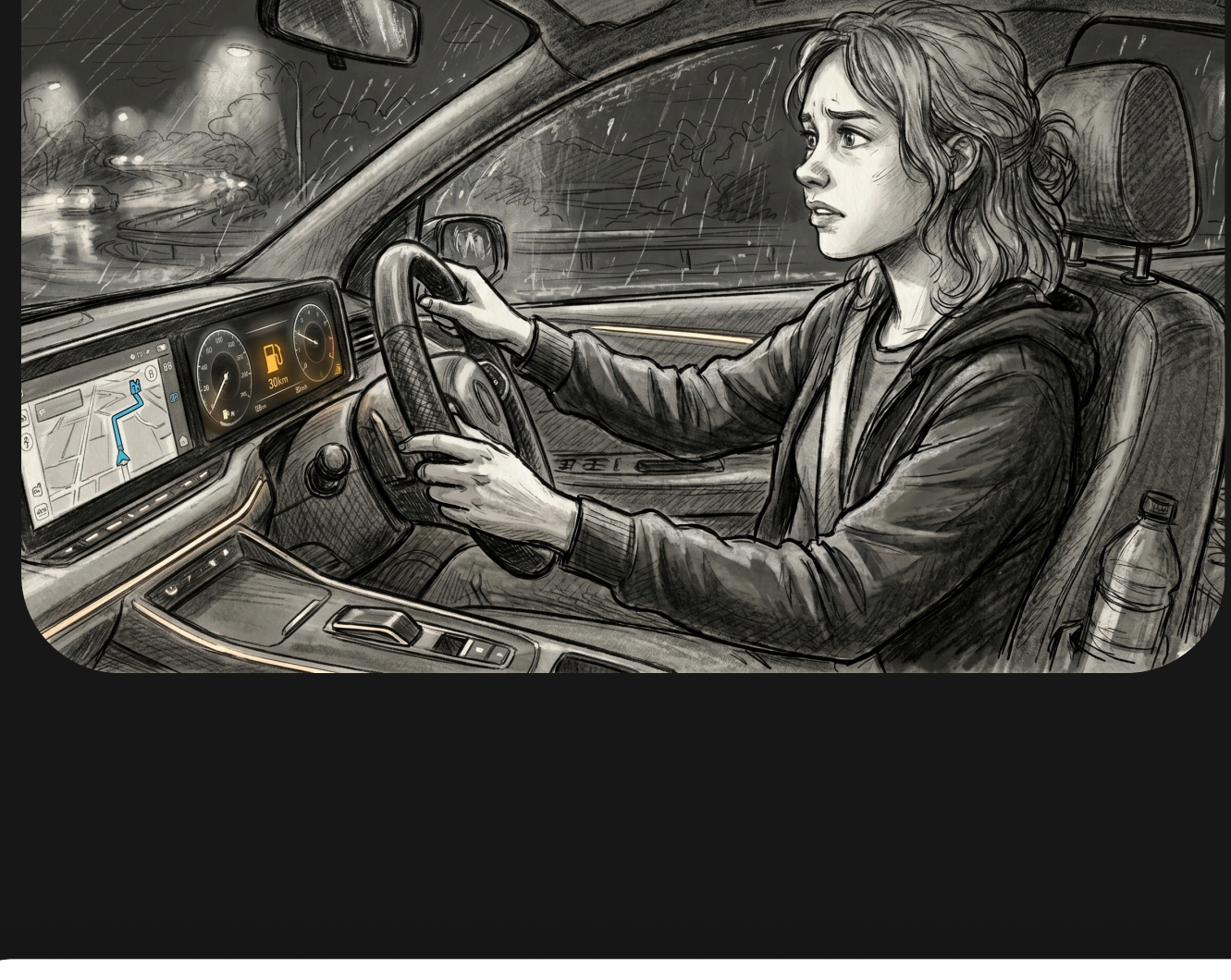
Outcome and Deliverables

1. Fully functional and scalable Generative GUI system
2. Empirical Data assessing Clarity, Informational Value, Cognitive Load, Distraction, Situational Awareness and Adaptivity
3. Design Recommendations for future research

Timeline

4 months

An Example Use-Case



This is Sara.

she is driving at night, in poor weather, with low fuel & is getting nervous

Her car "notifies" these constantly changing information through various data, "figures out" how this specific combination of information affects her in this specific moment, and automatically adapts the UI.

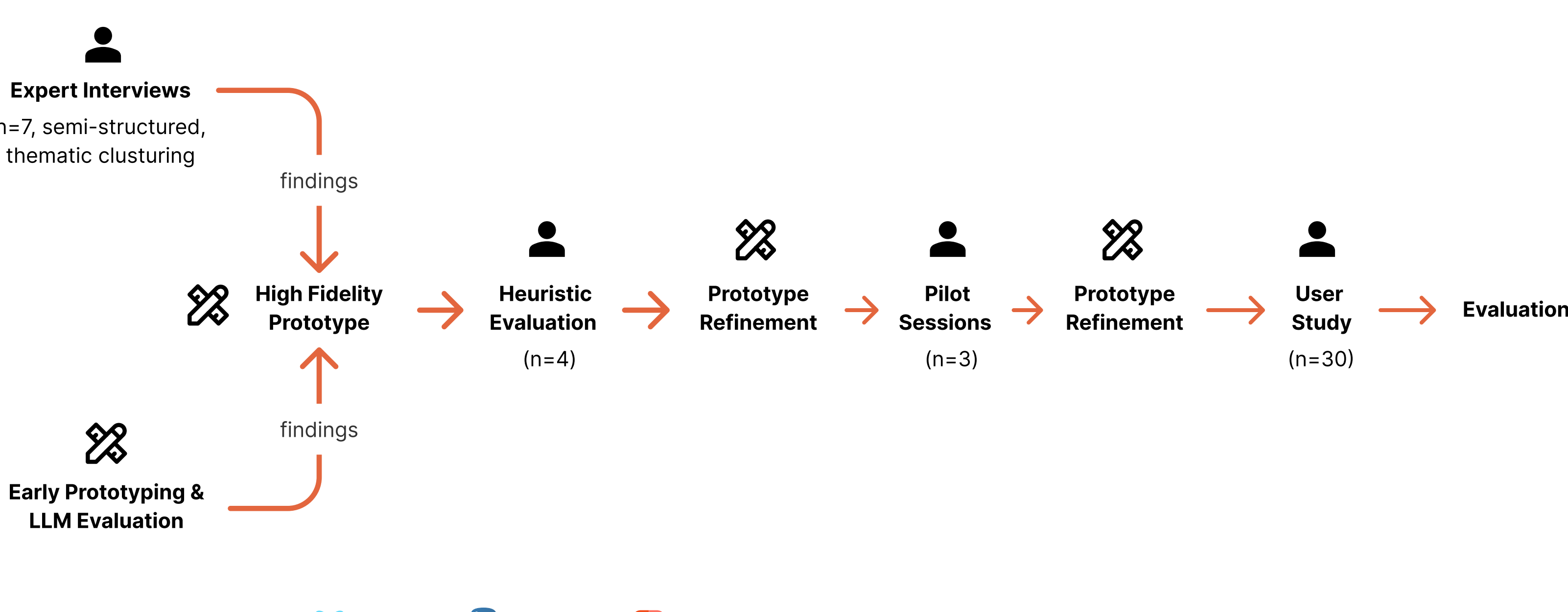
For example, the car may "decide" to update the infotainment screen by:

- hide non-essential elements
- boost contrast of important components
- emphasise nearby open gas stations within range
- reduce animations to address her nervousness

...this is what this project aimed to achieve. Creation of an infotainment system which generates UI on fly based on driver's needs, preferences and various contextual factors, without compromising UX and safety.

Research-through-Design (RtD) Approach

To realise the vision, I used RtD approach involving multiple steps grounded in human-centered principles.



1

Expert Interviews

Interviewed experts from different departments to understand their thoughts and pain points.

“Functions hidden under or split across different levels resulting in Frustration / Confusion

“Existing adaptive features based on deterministic, rule-based logic. (adding more use-cases = manual work)

“Industry actively moving towards the vision of “use-case-less” design

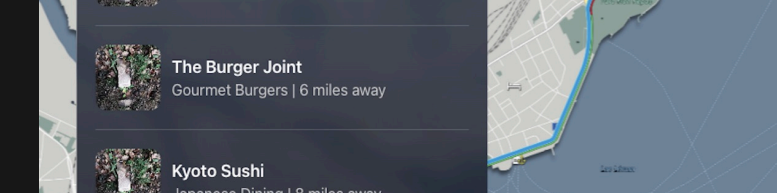
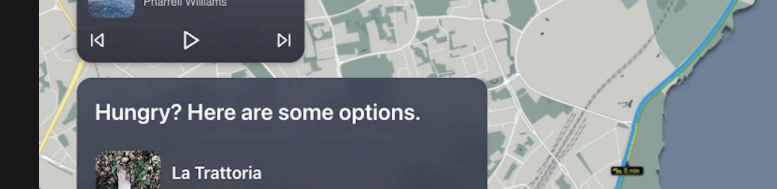
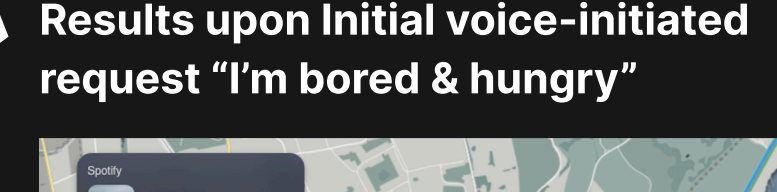
2

Early prototyping for LLM Evaluation

Evaluated different LLMs in terms of latency and their ability to generate and adapt UI. Gemini 2.5 Pro provided the best balance between adaptivity and latency. Each LLM was provided with 8 atomic UI elements.

- Gemini 2.5-pro diff. reasoning tokens **Ø 14s** (Overall Winner)
- Opus-4 diff. reasoning tokens
- GPT-5 GPT-5 mini (high, mid, low reasoning) **Ø > 60s** (Best Adaptivity)

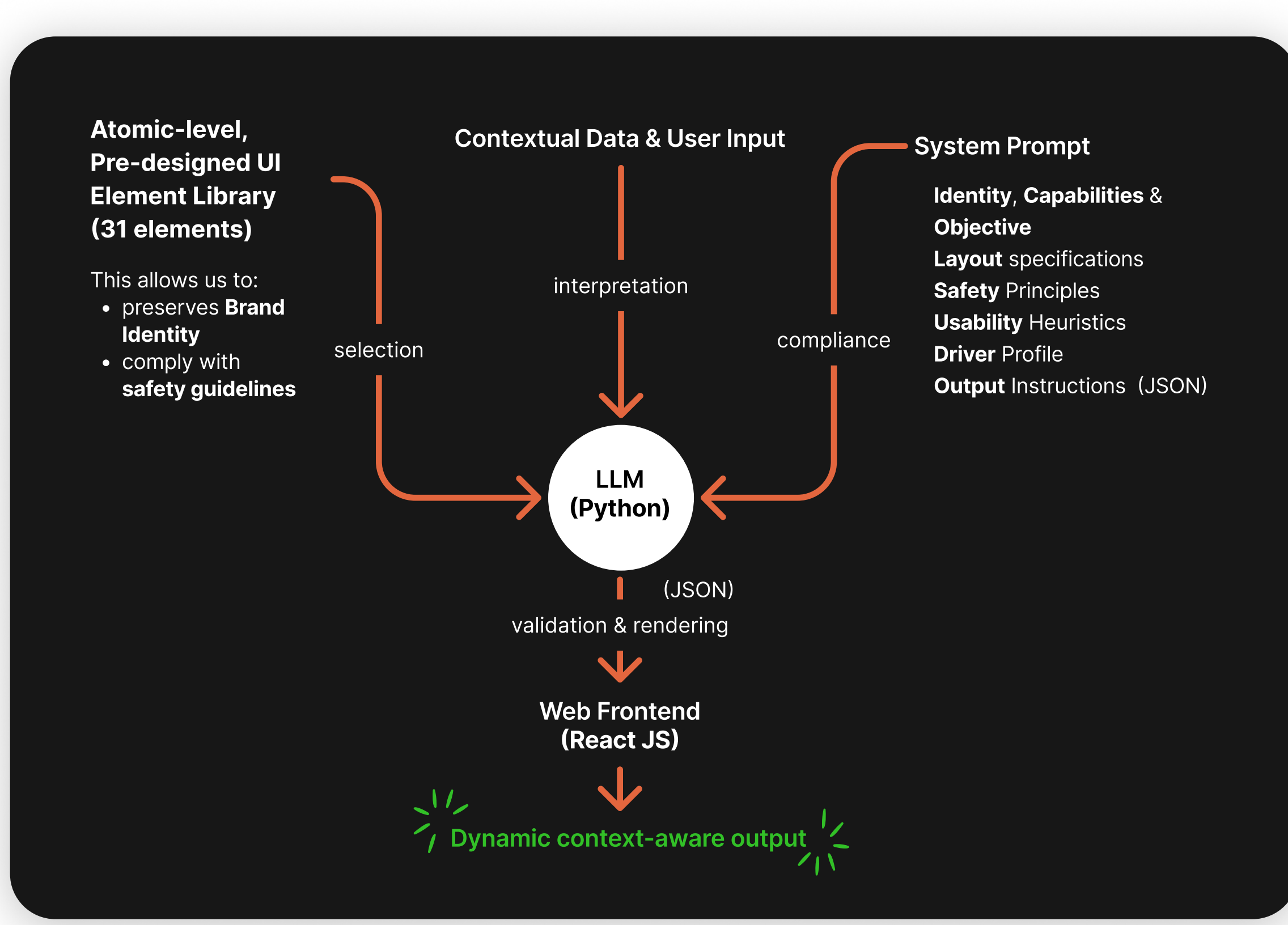
Results upon Initial voice-initiated request "I'm bored & hungry"



3

System Architecture for Hi-Fidelity System for the User Study

Findings from the above steps allowed me to conceptualise and finalise the architecture for the refined system, while considering the pain points of the experts.

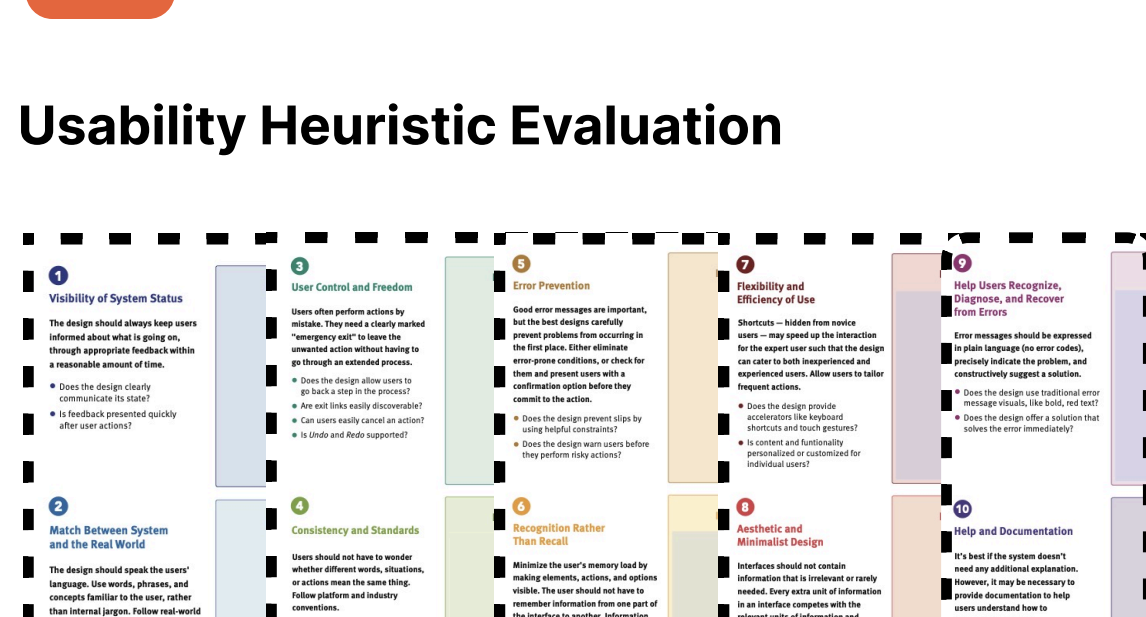


AI was given an ability to decide between two separate parts of the screen to show the UI, based on the priority, type of information, complexity, proximity, etc.

In order to facilitate natural interaction with the car, I designed, developed & integrated a fully functioning voice assistant into the system. Including different states such as idle, listening, thinking & speaking.

4

Usability Heuristic Evaluation



Individual usability heuristic evaluation sessions were conducted involving four designers. Each of them were provided with an evaluation workbook and a specific task which they were asked to accomplish using the AI system. In the process, they highlighted and documented the usability issues using workbook and rated each issue on scale of 0-4. Issues rated 2, 3, and 4 were resolved.

Severity Scale	Issues Identified
0 (No problem)	1
1 (Cosmetic)	6
2 (Minor issue)	7 ✓
3 (Major issue)	2 ✓
4 (Catastrophe)	2 ✓

5

User Study

30 Participants | **02** Systems

- (Prior + Sensitivity Analysis) 18 M, 12 F
- Experienced 2 systems (A/B)
- AI-Native System was compared against the pre-designed baseline using an A/B study.
- Both systems were integrated into the car's infotainment unit.
- Conditions were randomised to minimise order effects.

Group	First Run	Second Run
1	Video 1 + System B	Video 2 + System B
2	Video 1 + System A	Video 2 + System A
3	Video 2 + System A	Video 1 + System B
4	Video 2 + System B	Video 1 + System A

Following metrics were assessed using widely accepted and standardized, as well as custom measurement tools:

- Value (UEQ+)
- Clarity (UEQ+)
- Visual Aesthetics (UEQ+)
- Mental Load (NASA TLX)
- Distraction (custom 7-point Likert)
- Open Ended Feedback
- Personalization (custom 7-point Likert)
- Adaptivity (custom 7-point Likert)
- UEQ-S

Additionally, participants were asked to distribute a total of 100 points between system A & B to show their preference.

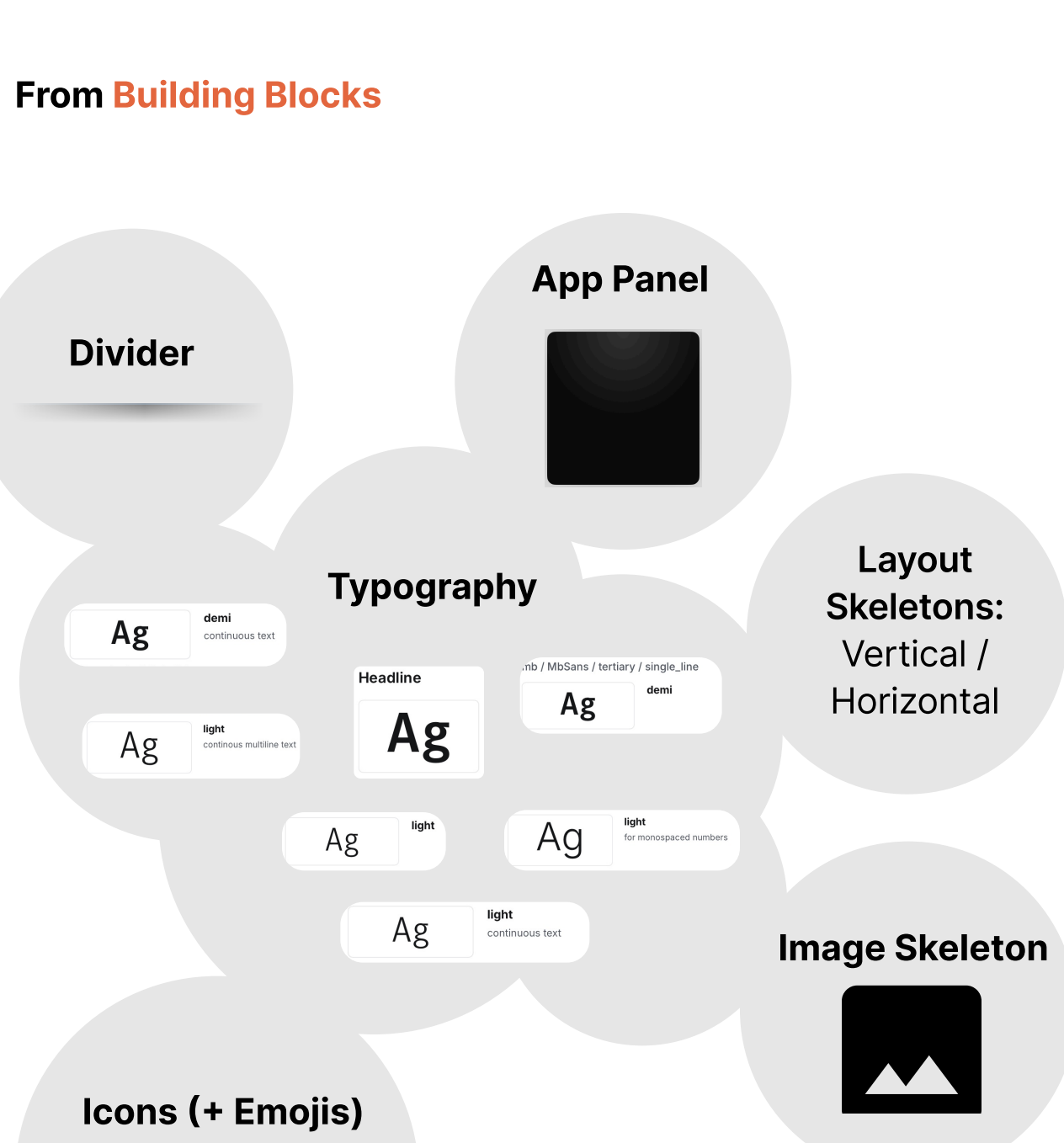


5

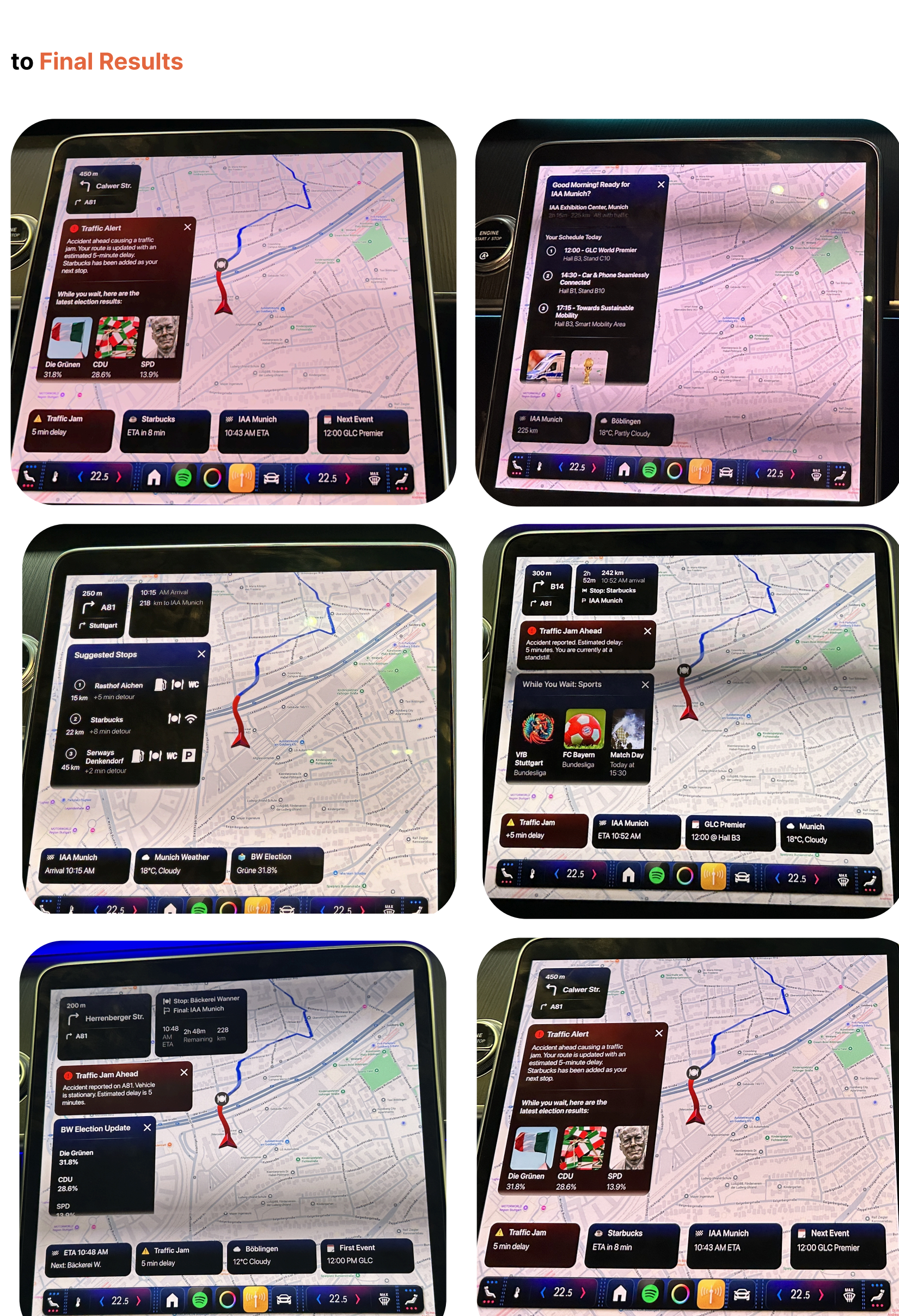
Results

Below screens were independently generated by the AI system in real-time using provided atomic UI library. Each screen is represents a personalised, context-aware output to support the driver under the specific storyline.

From Building Blocks



to Final Results



Overall preference - Point Distribution Scores

AI-Assembled System
Ø 48.73
14 People gave more than 50 Points out of 100
↳ 4 People out of those 14 gave more than 70 Points

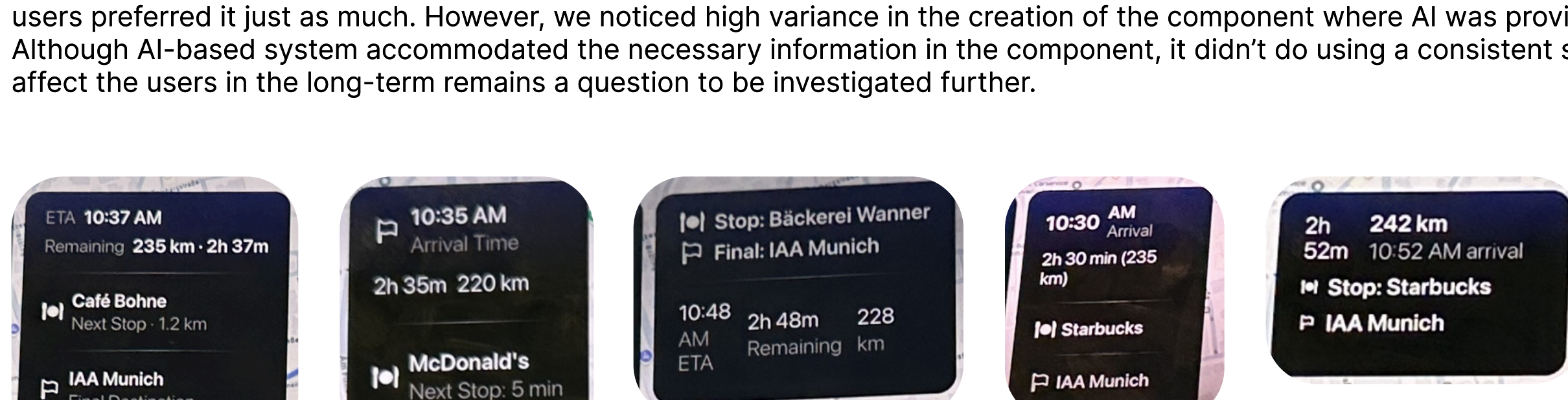
Pre-Designed System
Ø 51.27
15 People gave more than 50 Points out of 100
↳ 5 People out of those 15 gave more than 70 Points

Individual Metrics

Usability	p = .514
Clarity	p = .089
Distraction	p = .872
Situational awareness	p = .146
Value	p = .310
Cognitive load	p = .235
Personalization	p = .909
Contextual Adaptivity	p = .911

Variation in generated UI

The results showed that the AI-based infotainment system was rated similar by the participants in comparison to the baseline, indicating that users preferred it just as much. However, we noticed high variation in the creation of the component where AI was provided the most freedom. Although AI-based system accommodated the necessary information in the component, it didn't do using a consistent structure. How this might affect the users in the long-term remains a question to be investigated further.



The Take Away

Performance
AI-system performed on par with the baseline, with no significant difference noted under metrics related to usability, safety and UX, hence proving the core hypothesis.

Safety Insight

- UI variation acceptable for complementary content
- Variation in critical-components may introduce safety risks

Hybrid Strategy

While AI demonstrated great capabilities in assembling and generating UI on fly, high variations in UI might lead to confusion which may lead to safety issues. For now, it is recommend that designers should retain the control of critical components (e.g., navigation), keeping them predictable in terms of where they are placed, what information they contain and how they're structured.

While on other hand, as seen in the results, current AI capabilities can be well leveraged to communicate non-critical and supplementary information via UI.

- This allows AI-based assembly framework to act as an intelligent curator and builder constrained within safe boundaries.
- Simplifies Design and Development chain
- Leverages the available data to provide personalized experience