# Automated car interior layout design based on user activities

The evolution of the automated driving industry liberates users from driving tasks, thus creating more time for Non-Driving-Related activities (NDRAs), thereby transforming the car from a mere mode of transport to a mobile activity platform. This shift presents two main challenges: predicting the type of activities passengers will engage in within the automated cars and adapting the car's interior design to accommodate these activities. This project tackles these challenges with a focus on comfort, ergonomics, and user activity, promising valuable insights for the interior design of future automated vehicles.

A rigorous review of literature spanning 2014 to 2023 was conducted, with a focus on NDRAs in automated vehicles. The review retrieved 2315 papers from various databases, from which 47 articles encapsulating 66 cases and 50 types of activities were selected based on strict eligibility criteria. These activities were then categorized into 13 clusters, with the top five being Entertainment and online activities, Work and productivity, Interpersonal communication and interaction, Sleep and relaxation, and Observation and monitoring.

An exploratory experiment was conducted within a simulated automated vehicle environment to study the ergonomic and spatial needs of five significant NDRAs. These activities were the most representative of each of the five main clusters: talking to passengers, looking out the window, working on a computer, sleeping, and using an iPad for entertainment. This investigation filled a crucial research gap, providing valuable insights for designing more ergonomic and comfortable interiors for future automated vehicles.

The project further leveraged 3D modeling and Augmented Reality (AR) technologies to analysis the spatial requirements of users engaging in the identified NDRAs within a Range Rover Evoque. The research indicates that the current interior design of the Range Rover Evoque can accommodate average-sized (P50) users performing 5 major Non-Driving-Related activities at small or medium comfort joint angles, yet struggles to support larger comfortable joint angles, particularly for activities such as sleeping, entertainment, or work. The results suggest a future design could include slimmer seats and dashboards and potentially transition from a four-seater layout to a two or three-seater layout to provide more space for users for activities.

After evaluation of initial concepts for future automated vehicle interior design, I have combined their strengths and minimized their shortcomings to develop a final iteration. This design focuses on flexible space allocation by incorporating a slim dashboard and thinner seats and can shift between a standard four-seat configuration to a 2 or 3-seater layout, and include independent seats, and an adjustable table to cater to various user needs, setting the stage for the future of comfortable Non-Driving-Related activities within vehicles.

In conclusion, this project integrates theoretical and practical approaches, focusing on user activities and comfort in automated vehicles. The study leaves out considerations of commercial viability, manufacturing, and socio-cultural aspects. Future improvements should include these factors and align design with commercial and manufacturing realities.

*Literature review results: Five main clusters of NDRAs and their number of cases (L4 & L5 automated vehicles)*

| Cluster | Activity type |
|---|---|
| Entertainment and Online Activities (n=99) | Emailing/surfing the Internet (n=13) |
| | Play games (video games/board games/···) (n=18) |
| | Take selfie (n=2) |
| | Social media (n=8) |
| | Watch video/movie/··· (n=24) |
| | Use smartphone (n=17) |
| | Laptop usage (n=10) |
| | Browsing the tablet (n=5) |
| | Trade stocks (n=0) |
| | Shopping (n=2) |
| Work and Productivity (n=71) | Work/office task (n=26) |
| | Study/learn/training (n=4) |
| | Planning/thinking/analyzing (n=7) |
| | Making a to-do list/writing (n=2) |
| | Organization/clean up (n=2) |
| | Reading (n=30) |
| Interpersonal Communication and Interaction (n=60) | Texting (n=9) |
| | Video conference (n=6) |
| | Talking to passengers (n=21) |
| | Phone calls (n=17) |
| | Interaction with passengers/friends or family (n=7) |
| Sleep and Relaxation (n=45) | Relax/rest (n=15) |
| | Sleep (n=25) |
| | Use a massage chair (n=1) |
| | Wellness/praying/meditating/worshiping (n=4) |
| Observation and Monitoring (n=37) | Observing the landscape/looking out of the window (n=22) |
| | Monitoring the driving/watching vehicle or road (n=15) |
| | Communicate with other vehicles (n=0) |

*Exploratory experiments results: 16 postures based on maximum, average or minimum joint angles obtained for the 5 main activities*



| Posture \ Activity | Maximum angle | Average angle | Minimum angle | Other |
|---|---|---|---|---|
| Activity: Entertainment | | | | |
| Activity: Look out | | | | |
| Activity: Sleep | | | | Sleep flat |
| Activity: Work | | | | |
| Activity: Talk with other passengers | | | | |

*Design and iteration results: Preliminary car interior design for the future*
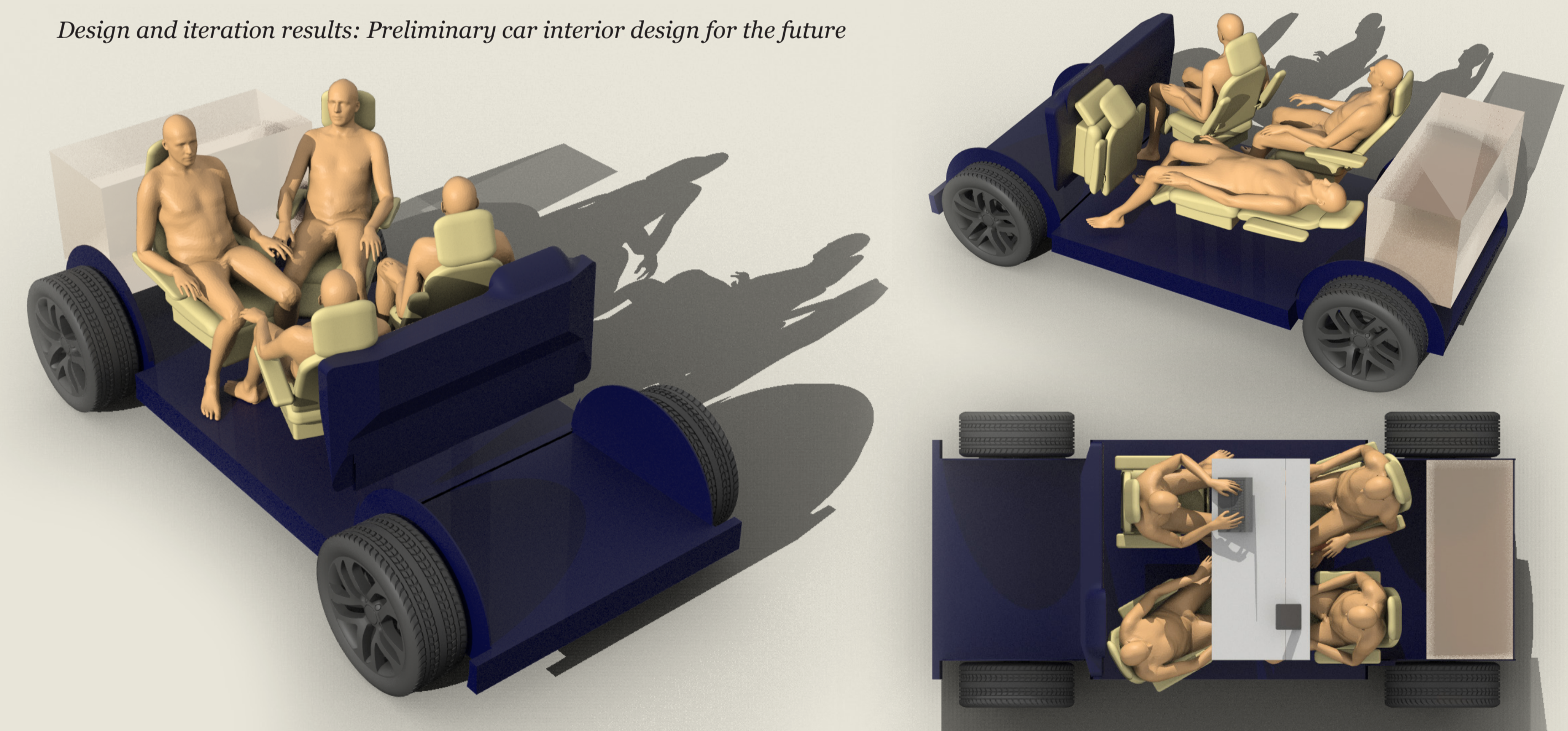
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