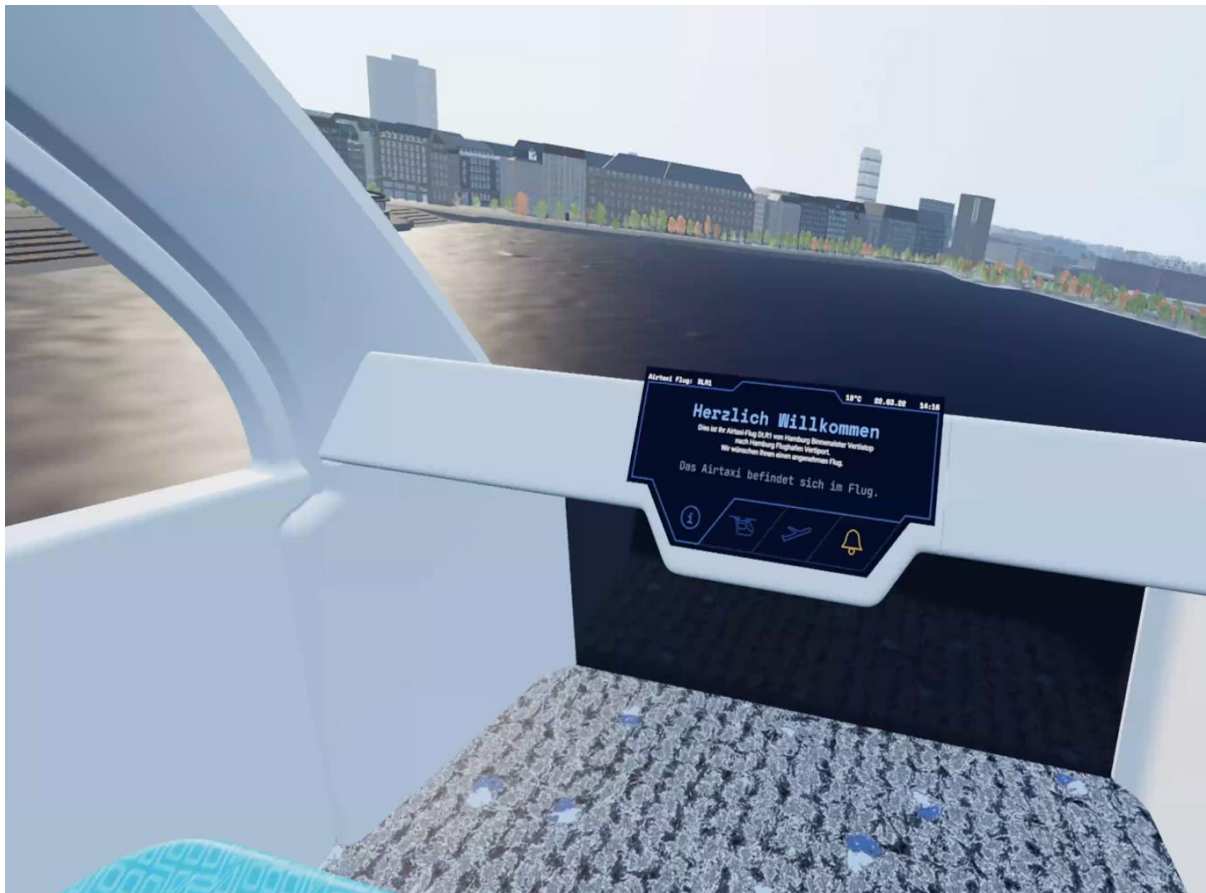


DESIGNING AND IMPLEMENTING A USER INTERFACE FOR AN AIR TAXI SIMULATOR

Graduation Report
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PREFACE

This report describes the process of creating, implementing, and testing a user interface for an air taxi simulator. It was written to meet all the graduation requirements of the Creative Media and Games Technologies studies at the Saxion University of Applied Sciences in Enschede, The Netherlands. The graduation period started in February 2022 and ended in June 2022.

This project was accomplished at the German Aerospace Center (DLR) in Braunschweig after I saw the job vacancy on a job employment website. For me, there is simply no way of not applying to work on air taxis, a project that sounds like pure science fiction. Even though the process went a lot smoother for a graduation project than I initially expected, I still had some problems to face. Fortunately, both my company supervisor Johannes Ernst and my graduation coach Tim Roosen were always available to answer my questions. I would also like to thank everybody from the DLR who supported me during this project and gave me the chance to be part of the future. Of course, I am also thankful for the support of my friends and family.

For my personal future, I managed to deepen my UI and UX skills while also gaining more professional experience and learning more about different design approaches and technical possibilities, making me a more flexible designer with a broader skill set.

Please enjoy your reading.

Jana Vieler

Braunschweig, June 14, 2022

ABSTRACT

To assess the acceptance of urban air vehicles by the general public, the German Aerospace Center (DLR) is conducting a study with a mixed reality air taxi cabin simulator. This simulator needed a user interface (UI), that visualizes information to increase the passengers' feeling of safety. The competition and trends were researched before a UI was designed and implemented into the simulator. Twelve test participants took part in a test and interview to evaluate the usability and design of the UI. Only small interaction issues were found during the test. The design was particularly well received and matched the users' expectations. But even if the results were positive, improvements can still be made.

KEYWORDS

Acceptance; Airport Shuttle; Air Taxi; Business Travel; Dashboard; Human Machine Interface; Interview; Passenger Transport; Safety; Screens; Transportation; Urban Air Mobility; User Experience Design; User Interface Design; Vehicle Concepts

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1. COMPANY OUTLINE

The German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) is a registered organization and therefore legally independent. It functions as the aeronautics and space research center of the federal republic of Germany. The DLR not only conducts its own research as a space agency but is also in charge of planning and implementing German space activities (Deutsches Zentrum für Luft- und Raumfahrt, 2019). Over 9000 people work at 30 locations, with an overall funding of 1261 million euros in 2020 (Deutsches Zentrum für Luft- und Raumfahrt, 2019, 2022).

This bachelor assignment was written within the project “HorizonUAM” at the location in Braunschweig, Germany. Around 1170 people work here in 14 institutes and facilities (Deutsches Zentrum für Luft- und Raumfahrt, 2020a). Located at a research airport, the DLR continues the work of the Deutsche Forschungsanstalt für Luft- und Raumfahrt, founded in 1936. The main research areas of this location are aeronautics, transport, space, and energy with a focus on safety, performance, and reliability of vehicles and air, road, and railway traffic. The test equipment is mostly created in-house (Deutsches Zentrum für Luft- und Raumfahrt, 2020b).

In the project “HorizonUAM”, under the leadership of the Institute of Flight Guidance, many different institutes collaborate together. In the Institute, the development and application of future processes and technologies of flight guidance, flexible use of air space, and the optimization of airport output, fuel consumption, and environmental impact will be researched, as well as the ever-changing role of the human operator and all technical operations onboard and on the ground (Deutsches Zentrum für Luft- und Raumfahrt, 2020c). The project itself wants to provide the first answers to the future of urban air mobility (UAM). UAM describes the transport of goods and passengers with highly autonomous flying vehicles in a future urban environment (Deutsches Zentrum für Luft- und Raumfahrt, 2021a). In combination with different institutes, the vehicles, infrastructure, operation of service, and acceptance of the public will be researched over the time of three years. Assessed will be the economic aspects as well the market opportunities up to 2050. Analyzing flight guidance concepts as well as familiar concepts, onboard systems, safety, and autonomous function of possible air taxi designs are objectives of that project (Deutsches Zentrum für Luft- und Raumfahrt, 2021a).

1.1 OBJECTIVE OF THE CLIENT

Within the project of HorizonUAM, a study will be conducted about the current acceptance of UAM and possibilities to increase it. It starts in July 2022. For this purpose, a mixed reality air taxi simulator was built (figure 1). This simulator needs a user interface (UI) to figure out what kind of and how much information is needed for the user to accept this new type of transportation. With a currently undefined number of test participants, that have no prior knowledge and represent the personas later discussed in this report, the following research questions will be investigated:

1. Does the current attitude towards UAM change after testing the air taxi?
2. How are typical flight maneuvers, for example: take off, landing, sinking, and turning, experienced?
3. How does the experience change with a flight crew member on board?
4. How is information about the flight experienced?
5. How is the interaction with the flight crew experienced in case of an accident causing a change of route?

These questions will be answered in two experiments, where the first one should answer questions 1 – 4 and the second experiment should answer research question 5. After an introduction and a briefing, four scenarios with different amounts of information and flight crew available to the test participant will be played through in experiment one. In the second experiment, the participant has to call a flight crew member to re-plan the flight mid-air. In-between the tests, participants have to answer questionnaires and an interview at the very end.



FIGURE 1: PHOTOGRAPH OF THE AIR TAXI CABIN SIMULATOR USED IN THE STUDY (DEUTSCHES ZENTRUM FÜR LUFT- UND RAUMFAHRT, 2021B).

The route that will be flown is always the same. The starting point will be near the Außenalster and the destination is the airport Hamburg, creating an airport shuttle scenario. There will only be one participant in the cabin and they will sit on the right side in the front row (J. Ernst, T. Laudien, A. Papenfuß, B. Schuchardt, M. Stolz, online meeting, February 23, 2022).

For this study, the simulator needs a UI that should display all relevant data to the participants. The researchers who will conduct the study had some ideas on what information they would like to test. At least the arrival time and a calling button for a crew member should be available as the lowest level of information. On the next level, the flight route and the current position, name of destination, duration of the flight, time left, next stop, punctual arrival, following flights, name of the flight, and contract person should be displayed. Current status, as well as Wi-Fi or other entertainment should not be displayed or have a low priority, since the participants should concentrate on the flight (J. Ernst, T. Laudien, A. Papenfuß, B. Schuchardt, M. Stolz, online meeting, February 23, 2022).

After conceiving and designing a UI that meets all of the requirements, it should be implemented and functional within the Unreal Engine 4 (UE4). This game engine is used to create the mixed reality environment. The design should be structured and easy to expand, so it can continue to be used throughout the whole project (J. Ernst, T. Laudien, B. Schuchardt, personal communication, February 07, 2022). Since the framework used to display and update values on the UI is HTML-based, the preferred filetype is SVG.

In addition, the design also needs to fit and be functional in the physical cabin. Preferably, it uses the already built dashboard in front of the front row. Inside the cabin, one has about the same space as in a five-seat car model (personal observation).

2. USER

At the beginning of HorizonUAM, a focus group study was conducted to determine potential customers, requirements, and expectations for a successful air taxi cabin design (Moerland-Masic et al., 2021). The participants were divided into four different groups, two based on demographic and two based on residential location. The demographic groups consisted of four male participants each, in the age groups of 18 – 39 years old (median age of 23.75 years) and 40 – 65 years old (median age was 50 years). The first location-based group consisted of one male and four female participants from small- to medium-sized towns, with a median age of 26.6 years. The second group consisted of two male and one female residents of metropolitan areas, with a median age of 38.67 years. The study took place in December of 2020 over skype. Each meeting had a duration of three and a half hours (Stolz et al., 2021).

First, participants were asked to talk about their experiences with local transportation. The favorite of all groups was the bicycle because of its flexibility, avoidance of traffic jams and crowded parking spots, exercising component, and easy integration with other means of transport (Stolz et al., 2021).

Afterwards, the groups were asked to design their own cabins. The 18 – 39-year-olds showed high interest in innovative technologies and smartphone connectivity. They would like to have information about the location displayed. The older age group was more interested in displaying flight data and Bluetooth connectivity. Metropolitans were also interested in Bluetooth, a warm color scheme, and entertainment. Entertainment was also an important factor for participants from smaller and medium-sized towns (Stolz et al., 2021).

Overall, factors like hygiene, safety, comfort, and accessibility should be considered. Especially in the beginning, it should be designed like a once-in-a-lifetime experience (Stolz et al., 2021).

Based on this study, other data collected and personal observations (F. Reimer, online meeting, February 21, 2022), three personas were created (Moerland-Masic et al., 2021) and will be continued to be used for this assignment. These three personas should represent three different generations of possible users and their tendencies in character. The first persona is a young student, representing generation Z. She is looking for authentic travel experiences, concerned about the environment, with her own political and ethical ideals and her friends and family are scattered around the globe. Owning a car gets more and more unattractive to this generation. They know how to use technology efficiently. This target group is not as important for the airport shuttle case, since it is more likely for them to use the air taxi for other cases.

The second persona, which can be seen in figure 2, should represent the generation Y. Inclusion was an important factor from the very beginning, so the decision was made to give him a wheelchair. He lives and works in different places and highly values his work-life balance. He is looking for maximum social media rewards when traveling. Curiosity, luxury, and trends are important to this generation, as well as equality in design, privacy, and open spaces. This persona can be used in all use cases but specifically when talking about business travel and sub-urban to urban transportation.

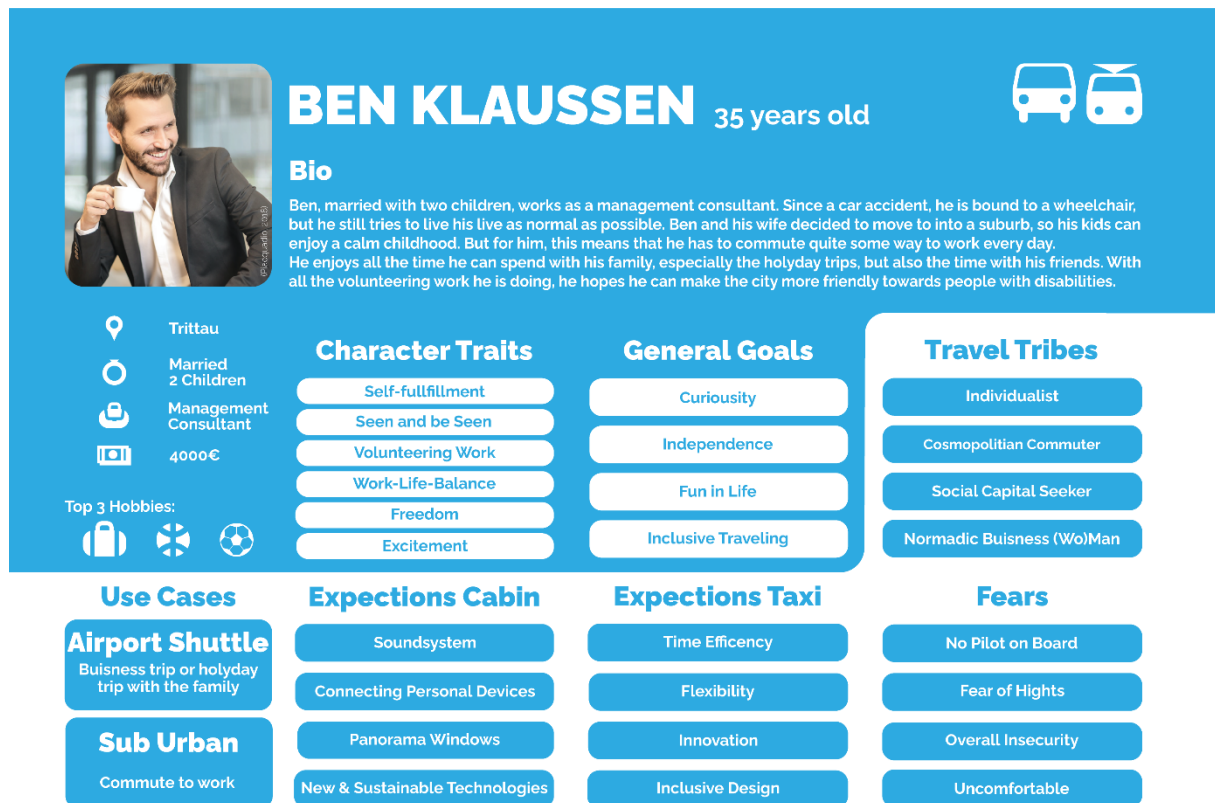


FIGURE 2: PERSONA OF THE TARGET GROUP. REFERENCE FOR THE PHOTOGRAPH: (PIACQUADIO, 2018).

The original visual representation of the persona resembled more a collection of information that missed structure and was clearly work in progress. Therefore, it was decided to recreate it, to fit better to the project's needs and add more structure to its appearance and information. The result can be seen in figure 2.

The last persona should represent the generation of current baby boomers. This persona is a response to the aging society, especially in Germany. They are healthy and active, have more money at their disposal than the generations before them, and want to enjoy their retirement. They are looking for simple and easy solutions that require the lowest amount of effort but they are also the generation that is the most likely to have mobility or other health needs. Their families live in different places so they might use an air taxi as an airport shuttle. They require the most explanation and are skeptical about technology. This persona represents current people aged 65 and older, but the whole project also wants to give out a look into the future. So future seniors are going to have different needs than current best agers.

But it was also discovered that people of all ages are equally interested in information about the flight, while being on the flight, and not just older people. There is a general longing for safety and feeling in control. So, all groups should be taken into account while designing the UI, but to the focus of the study, which is business travel, the person representing Generation Y (figure 2) matters the most and will be the main target group (J. Ernst, T. Laudien, A. Papenfuß, B. Schuchardt, M. Stolz, online meeting, February 23, 2022).

3. MARKET

3.1 COMPETITION

To get a general overview of the competition and to see who is already experimenting with this new technology, but also to see how far possible solutions in development already are, a short market competition was conducted.

There are about 200 companies that are currently involved with the development of vertical-takeoff-and-landing vehicles (Gomez, 2021). An example would be the CityAirbus NextGen from Airbus. It offers four seats and a promised range of 80 km by a cruise speed of 120 km/h. The first test flight is planned for 2023 (Airbus, 2021). Since 2015, Lilium is developing the technology that is currently used in their seven-seat model. The jet, which is promised to have a top speed of 280 km/h, is set to launch commercial operations in 2024 (Lilium N.V., 2021a). In the same year, Joby Aviation Inc. wants to enter the commercial market as well. They are planning new flight testing for this year (Joby Aviation, Inc., 2022). Within the next three years, the VoloCity from Volocopter is supposed to take a flight, too (Volocopter GmbH., 2021).

3.2 TRENDS

To get a general idea of what the current design philosophy of air taxis is, a short research was done. Since this is a new technology with basically no commercially vehicles available yet, a basic research was conducted to understand design philosophies in cars, too. Air taxis should feel familiar to cars, so considering their dashboard designs seems like a logical step to proceed. In the end, current design trends were researched to secure a modern and up-to-date look.

3.2.1 CABIN DESIGN

The cabin designs used by competitors are similar to current car designs. This should create a sense of familiarity and through that security in the user. The color contrasts are strong. Dark colors should evoke a sense of luxury while light colors should make it look clean. Some designs feature wooden parts and green colors, to make a connection to environmental awareness. The designs are clear and feature large windows with bionic shapes. Seats are arranged similar to the ones in cars. Overall, they want to convey a modern and safe design (Moerland-Masic et al., 2021). An example of an interior design can be seen in figure 3.



FIGURE 3: EXAMPLE OF THE INTERIOR DESIGN OF A LILIUM JET WITH FOUR SEATS (LILIUM N.V., 2021B).

3.2.2 AUTOMOTIVE UI

As described above, air taxi solutions draw inspiration from normal cars. Therefore, it would only make sense to have a look at how traditional manufacturers would design their UIs.

There are two kinds of applications for cars that need to use a user interface: applications that are built into the car and, since recently, apps on smartphones that interact with the car (EGO Creative Innovations Limited, 2021). This trend analysis only focuses on the former. At first, automotive UIs had the sole purpose of informing the driver about the state of the vehicle. But over time, the UIs developed into advanced infotainment systems. Now, they try to imitate the functions of smartphones, but there is no standard in design. Almost every manufacturer has their own approach to their car UI and develops it in-house. Both Tesla and Porsche feature their own OS, with touch controls and voice assistant. Both have a minimalistic and high-contrast design, which makes it easier to use (Sirch, 2020). Only few manufacturers feature the operating system Android Automotive OS by Google. Apples CarPlay is not even an operating system on its own but only lets the user interact with their iPhone apps over the car's screens (EGO Creative Innovations Limited, 2021). The Polestar 2 uses the power of the android system and with everything it has to offer, it is considered more future-proof (Sirch, 2020).

3.2.3 GENERAL UI DESIGN TRENDS

To ensure that current design ideas are actually trends, six lists that claim to feature design trends were collected and placed on the columns of table 1. From these lists, all design trends were extracted and placed along the rows of the same table. Whenever a trend was mentioned, a cross was made under the source. In the end, every mention of a trend was counted. The higher the number of mentions, the more likely it is to be an actual trend. In this way, a quick overview can be generated, as well.

The conclusion of table 1 therefore is: Higher transfer rates and stronger hardware are as accessible as ever before (Hannah, 2021), so designers can use more resource-heavy designs to convey their ideas. 3D models and objects are becoming more and more popular, as well as animations and designing for VR or AR usage (Erdem, 2021; Fabian & Göbölös, 2021; Hannah, 2021; Malewicz, 2021; Musienko, 2021; Shakuro, 2021). A possible reason for this is the announcement of the metaverse plans of the company behind Facebook and the excitement it generated (Fabian & Göbölös, 2021; Malewicz, 2021). Another trend is the incorporation of a dark design into websites as well as micro-interactions (Erdem, 2021; Fabian & Göbölös, 2021; Hannah, 2021; Musienko, 2021; Shakuro, 2021). But the current trends are also open. Generally, in favor are big and bold fonts with dynamic colors or strong contrasts, even gradients are used (Erdem, 2021; Fabian & Göbölös, 2021; Hannah, 2021; Malewicz, 2021; Musienko, 2021). Asymmetry, even brutalism finds its way into current UIs (Erdem, 2021; Malewicz, 2021; Musienko, 2021) but also minimalism and a more natural and environmental approach can be found (Erdem, 2021; Musienko, 2021).

TABLE 1: TREND MATRIX TO DETERMINE HOW OFTEN SO-CALLED DESIGN TRENDS WERE ACTUALLY MENTIONED IN DIFFERENT SOURCES.

Trend/Source	Careerfoundry	Merehead	User guiding blog	UX collective	UX Planet	UX Studio	Number of Trends mentioned
3D		x	x	x	x	x	5
Animations	x	x	x		x		4
AR		x	x			x	3
Asymmetry		x				x	2
Bold Fonts		x	x	x		x	4
Brutalism		x		x			2
Dark mode	x	x	x			x	4
Design Systems			x				1
dynamic color patterns				x		x	2
Foldable designs						x	1
Functional	x	x					2
Glassmorphism				x			1
Gradients		x	x				2
Holographic				x			1
Inktrap fonts						x	1
Low code platforms						x	1
Micro Interactions	x	x	x		x	x	5
Minimalism		x		x			2
Natural		x		x			2
Neumorphism			x				1
Real photos		x					1
scrollytelling					x	x	2
soft, floating shadows		x					1
strong color contrasts	x	x					2
system-like UI						x	1
Unique Illustrations		x	x			x	3
Visualization of Data					x		1
Voice Recognition	x		x				2
VR		x	x	x		x	4

NOTE: SOURCES OF THE ARTICLES FROM LEFT TO RIGHT: (HANNAH, 2021), (MUSIENKO, 2021), (ERDEM, 2021), (MALEWICZ, 2021), (SHAKURO, 2021), (FABIAN & GÖBÖLÖS, 2021)

4. PROBLEM STATEMENT

UAM is a new technology that is not as well researched and documented compared to more traditional means of transportation. To prove assumptions about the well-being of passengers right or wrong, a study with an air taxi simulator will be conducted, where participants have to react to different amounts of available information. Right now, there is no way to display all relevant data inside the cabin for a passenger to see and interact with.

4.1 RESEARCH GOALS

The project is a success when all the information that is required by the study can be displayed in an easily understandable manner that fits within the design concept of the air taxi. It is implemented and functional within the simulator and was set up in a structured and expandable way.

5. MAIN QUESTION

How can an interactive and flexible UI dashboard design be created in the SVG-filetype, that shows and conveys all relevant data to the participants in the business travel scenario of the study, to increase their feelings of safety and information?

5.1 SUB-QUESTIONS

1. How can a technically advanced and futuristic, consistent visual style be created that fits the (initial) uniqueness of the project and the business travel target group?
2. How can an interactive prototype be designed that gives an impression of the UI functionalities, to generate the same expectations for all team members?
3. How can an SVG-file be created, that displays the design and information but also functions in the simulator framework?
4. What information is needed to increase the feeling of safety within the user while traveling in the air taxi?

6. METHODOLOGY

1. How can a technically advanced and futuristic, consistent visual style be created that fits the (initial) uniqueness of the project and the business travel target group?

One moodboard will be created to give the project a clear direction. It will be used as a reference throughout the project to keep the style direction consistent. The pictures used on this moodboard are either from the internal picture archive of the DLR or from websites that provide commercially free images.

Additionally, a stylesheet will be created. First, different iterations with fonts and colors will be produced to find the combination best suited for the project. The colors will be found by combining color theory with tools like Adobe Color. For fonts, only commercially free offers can be used.

After a final decision, nothing will be changed. It will be used as a reference for the following steps, so every decision follows the same design.

2. How can an interactive prototype be designed that gives an impression of the UI functionalities, to generate the same exactions in all team members?

Once the style is chosen, first sketches of the design will be created on paper. From these sketches, one design will be used to create a low-fidelity prototype in a tool like InVision. This prototype can showcase the needed functionality and conveys the idea with the most resemblance to the final product. In this way, every person involved with the project knows what to expect and what is achievable within the time frame.

3. How can an SVG-file be created that, that displays the design and information but also functions in the simulator framework?

The display will be delivered in the SVG-file format to be compatible with the finished framework. Due to lacking experience in working with the file format, desk research will be conducted. The focus will be on documentation and tutorial videos. In this way, a foundation of knowledge can be created. This is a necessary step, because if there are any restrictions or special preparations needed it would save time by knowing this beforehand and adjusting the workflow accordingly.

4. What information increases the feeling of safety and information within the user while traveling in the air taxi?

Not much data is already available on this subject, but the psychologists involved in this project already made a list of information they think would already increase the feelings of safety if they are displayed properly. This information will be incorporated to get a first indication of what will be considered to increase safety.

In addition to that, an interview will be conducted with twelve participants where they have to answer questions about their feelings regarding safety and what they think is still needed to improve it. This information can then be used to give further recommendations.

7. SCOPE

7.1 DELIVERABLE

The goal of this project is to develop a prototype of a graphical UI dashboard.

7.2 INCLUSIONS

Basic interaction and functionalities are present, as well as all information requested by the team that prepares the study. The interface has graphics and will work within the mixed-reality air taxi simulator. Values that change during a flight, like speed and flight height, can be updated live.

7.3 EXCLUSIONS

Even though the air taxi is a mean of transportation that should be used by everyone, the main target group in this project will be business travelers that are part of the generation Y, that want to fly from the city center to the airport. This also means there will be no consideration given to other use cases, as well as people from other age groups or possible passengers with disabilities, since they are not a considered demographic for the initial study. Onboard entertainment will also not be considered since it would distract too much from the actual flight experience. The information about an operational disturbance will not be present in the prototype, since the pre-study does not involve such a scenario.

7.4 ASSUMPTIONS

Since this is one of the first studies conducted about air taxis, it cannot be expected that the solution will be the best option. It will be a first attempt to find out what information is actually needed and relevant, since the study after the production of the display will also be about finding out what data actually helps to strengthen the feelings of security and control.

7.5 CONSTRAINTS

Involvement of actual members of the target group in a pre-study is considered too much organizational effort at this stage of the project. Immediately after this project will be finished, an official study with actual members of the target audience will be conducted anyway, so the focus will lay on internal functional testing with colleagues.

8. IDEATION

8.1 BRAINSTORMING

To come up with possible ideas and solutions, a brainstorming was done first. No real boundaries were set in the beginning, to ensure the use of full creativity. The evaluation of the actual feasibility of any idea produced during this early stage will be done later with SWOT analysis. The process was organized in a loose mind map. At first ideas about the overall design were gathered in a process of rapid ideation. Thoughts were spent on colors, fonts, shapes, and attributes connected with them. Then size and possible placement were considered, as well as display ratios. In the last step, all the information and screens possible were brainstormed in rapid ideation. All ideas were written down on post-its and stuck on a whiteboard. The result is shown in figure 4. Only the author of this report was involved in this step.

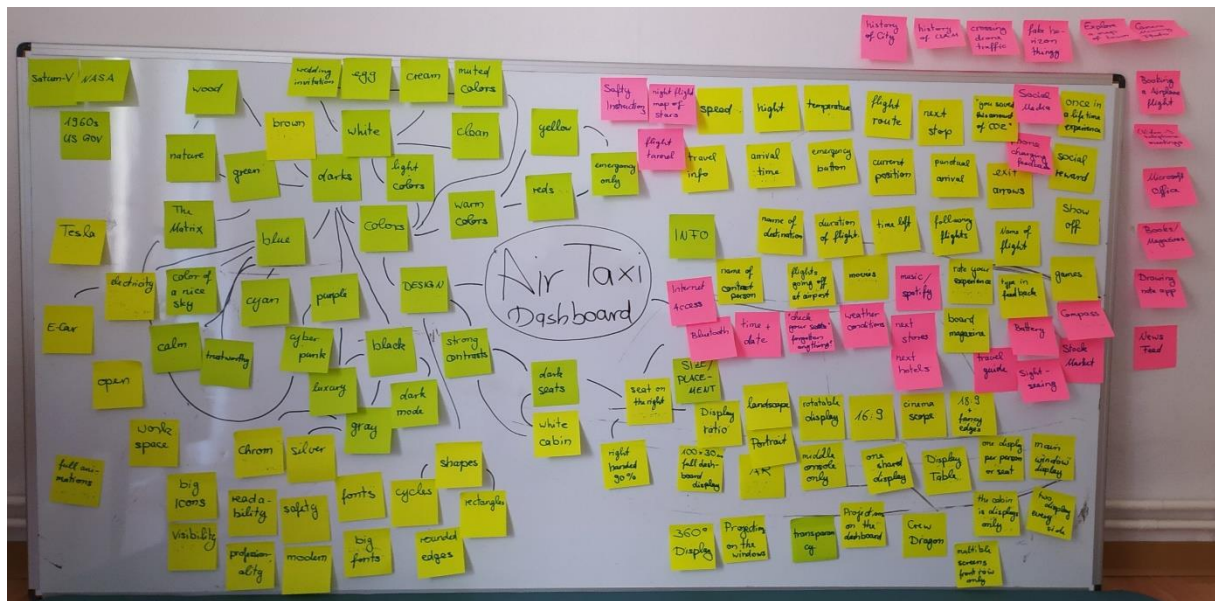


FIGURE 4: RESULTS OF THE BRAINSTORMING SESSION

8.2 COCD Box

To evaluate every idea that came up during the brainstorm session, the post-its were sorted into the COCD box (figure 5). The COCD box categorizes ideas based on originality and feasibility. The ideas can be sorted into four categories: obvious and unfeasible (black), obvious and feasible (blue), original and feasible (red), and original and unfeasible (green) (School of Creative Thinking, 2021).

The black box is for ideas that are unoriginal or unfitting and undoable within the given timeframe and therefore unsuitable for the project. Blue ideas are usually the first ones that come to mind during a brainstorm session. It is recommended to write them down anyways, to get them out of the system and make room for newer, more surprising ideas. Red ideas should always have more weight than other ideas, since they are original and surprising but also achievable within the timeframe. Green ideas are original but outside of the project and should be considered for future iterations.

Ideas from the three boxes blue, red, and green are taken to create original and surprising concepts.

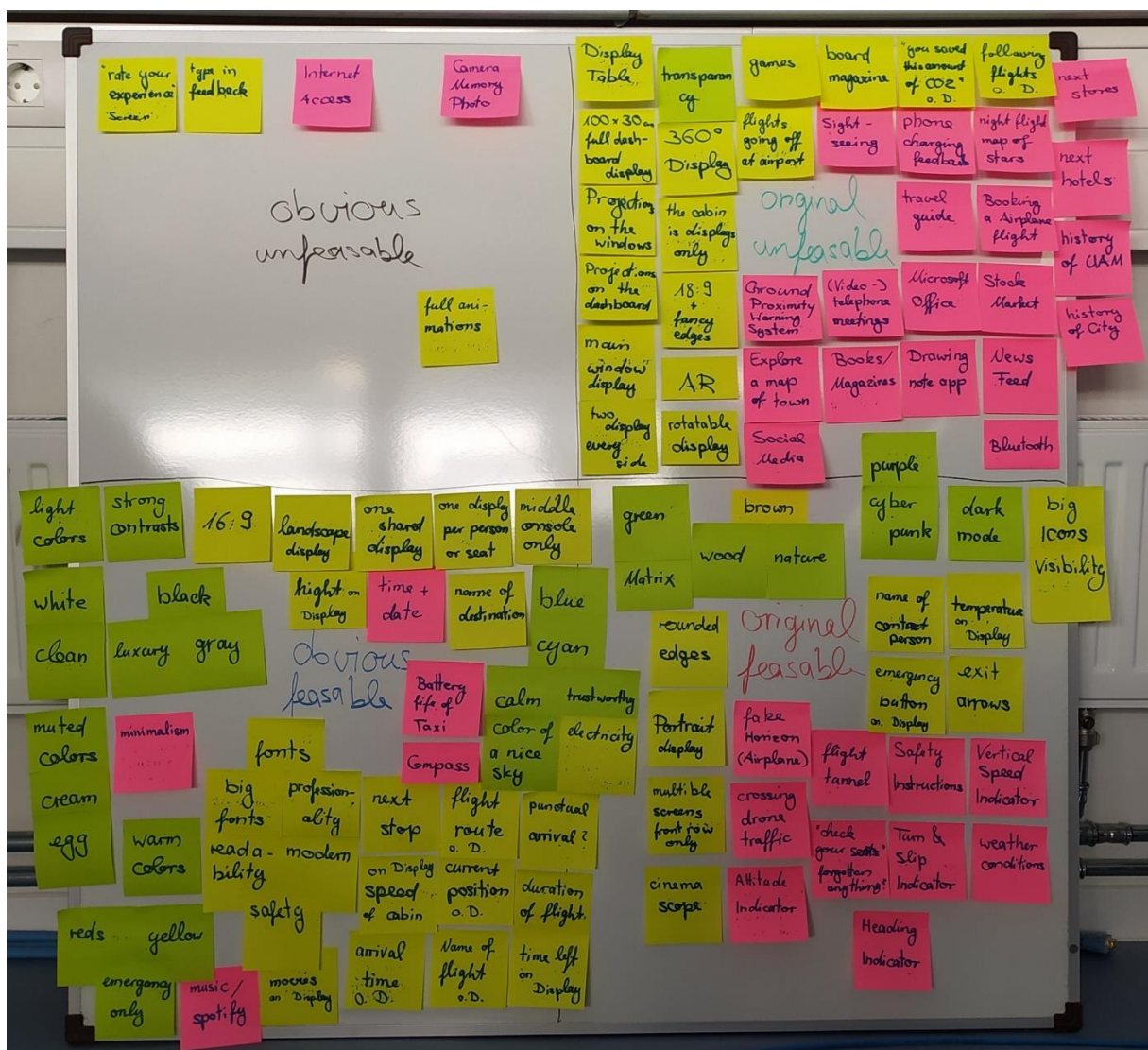


FIGURE 5: RESULTS OF THE COCD BOX

8.3 CONCEPTS

Based on the ideas in the COCD Box, the following 10 concepts were created. To create these concepts, at least one idea from each of the three boxes was used to create a full concept. It was important that for each concept, the display location was clear as well as its size and orientation, its intended focus, and where the service button is located. Additionally, color themes and a first look and feel were nice to see already but it is not a requirement, since this is not the focus of this phase.

8.3.1 FAMILY TABLE

A display in the middle of the cabin, like a table. The seats are arranged around it. It is one big display that every passenger would share with each other. It is brightly colored with a focus on family-friendly design. The table design is ideal for games or a big map. The map shows not only the current position, the route, name of the destination, and arrival time but also important landmarks and historical information about the city and an overview of hotels and stores nearby. The table can operate in different modes, such as tabletop mode where all passengers can play games together or where the table turns into a giant piece of digital paper for everybody to draw on. Next to every seat will be the service call button. Close to them, mobile device chargers could be placed. The free space under the table could be used as storage space.

8.3.2 CONFERENCE TABLE

Similar to the family table concept, this idea offers a table in the middle of the cabin, too. But instead of the table surface being a screen, the display elements will be projected onto the table and can be turned off. This solution focuses on business travelers in particular and therefore offers all required information in a professional, minimalist style. In addition, it should offer information more relevant to this type of traveler, like news, stock market, and maybe even office applications to continue productivity. If preferred, own devices can be placed on the table and worked with, the projection then can be turned off or used as a second screen. Power outlets are available as well as a special function for video and phone meetings, alone or with every passenger on board. The service call button would find its place in the middle of the table.

8.3.3 ECO DISPLAY

This portrait-mode display concept emphasizes the environmental friendliness of the electric engine of the air taxi. It is placed in front of every passenger. The prominent colors are muted browns and greens to evoke feelings of wood and nature. The service call button would stand out and be placed on top of the screen. Social media as well as different magazines and books are available on the display. The map offers tourist information as well, but this time the focus would be on second-hand shops and smaller hotels on the map. When the flight is over, a "you saved x amount of CO2 by flying with our air taxi" message shows up before the prompt to leave the vehicle will be displayed.

8.3.4 PROJECTIONS ON THE WINDSHIELD

No physical screen is needed, the information will be projected onto the windshield window. All information could be visible at once or the passengers can choose themselves what information should be visible. Information about tourist hotspots can be shown directly on top of the real location, as well as historical landmarks or just simply the flight route. "Before and After"- Pictures can be shown. In need of human assistance, a video feed for the air taxi support can be projected onto the window. This concept would fully embrace the "once in a lifetime" experience it will be for most passengers in the beginning. With the right colors and fonts, a complete "the future is now" feeling can be evoked and supported.

8.3.5 EVERYTHING IS A DISPLAY

The complete inside of the cabin is a display. In this way, walls and dashboards could disappear and show the complete surroundings of the cabin. Information about the city and tourist spots are directly visible on top of the real locations as well as the flight route. The service button can be anywhere, as well as where the called support can show up. The 360° view will be a once-in-a-lifetime experience. Fonts and colors should be minimalistic, to keep the focus on the experience.

8.3.6 AIRPLANE COCKPIT

Over the whole dashboard, from door to door, one screen will display all information at once. The focus lies on flight-related information, but with so much space there is enough room for other things and entertainment as well. In colors and design, it should resemble an airplane cockpit. If you cannot see what is going on on the other side, you can just swipe it over in front of you. The service button will always be very prominent in the middle of the display, so it is always in the same place.

8.3.7 ROTATABLE DISPLAYS

Every passenger has their own display. Normally it is presented in portrait mode, with all important information about the vehicle available. If the passenger prefers to watch a movie or other entertainment, they can tilt the display into landscape mode and watch it on the “bigger” screen. In every mode, the service button will be available.

8.3.8 TWO SCREENS FOR ONE PASSENGER

Effectively this is only one landscape screen in front of every passenger, but it is split up into two portrait sections. The first section is filled with information regarding the taxi, flight route, and the service button, while the other side can be personalized with information more interesting for the passenger, such as news or magazines. If the passenger wishes, they also have the option to show one of these options in full screen, for example, the personalized screen when they want to watch a movie.

8.3.9 THE AIRBUS

Additionally, to a personal display every passenger has in front of them, one screen with general information could be placed at the front under the ceiling, like some buses currently offer (personal observation). This screen is not interactive and cycles through the information by itself. The personal screens are interactive and focus more on entertainment and additional information. The service button can be found here, too.

8.3.10 BUSINESS SUPPORT SCREEN

Every passenger has their own display, with all the information available. The passenger might have to navigate through a short menu to find what they are looking for. The service button should always be available, though. The general look should be professional and minimalistic with dark colors to contrast the white cabin. The screen should have a ratio of 18:9 so it fits the panel in the middle of the dashboard, but it should also incorporate the fancy round edges to create an eye-catcher. The focus is business travelers, so most of the information besides the vehicle-related information should be focused on that as well. This display should support the traveler who already brought their own device with them and not be the main attraction of the cabin. In the beginning, the cabin itself might be a great attraction but later it will be a mean of transportation like everything else and then it should not distract the traveler who has work to do. Entertainment can be added later. Time is an important factor. Current time, as well as arrival time and plane schedule, could be available, too.

8.4 SWOT ANALYSES

From the 10 concepts, the 3 most promising and fitting were picked to be analyzed with the SWOT system. Those ideas were the conference table, the airplane cockpit, and the business support screen. The full SWOT tables can be found in Annex A: SWOT Analysis Tables.

8.5 FINAL DECISION

After the pros and cons of the three ideas were evaluated with the SWOTs, the final decision was made. The business support screen will be developed further.

The points that make the conference table unsuitable are that in the current physical cabin is not enough space to fit a table in there comfortably. It could simply not offer the space to work comfortably on the table but also to get in or out. In addition, this physical table and the projectors would lead to additional costs. Another factor that would add to more costs is the licenses for office programs. But even then, the programs need to be adjusted so they work within the operating system of the cabin and have a sufficient method of input. Even under these circumstances, it should still be considered unlikely of business travelers to use this offer since many companies have policies against working on computers that are not company property in fear of software viruses and theft of secrets. In addition, with the clear focus on productivity, it is not suitable for the study that will be conducted, which is more focused on the general overall experience of a flight and this would clearly distract from it.

The second concept, the airplane cockpit is unfavorable because there would be not a single place in the physical cabin where the passengers could see the whole display at once. While interacting with it, they could easily interfere with one another which could make the ride uncomfortable. By adding the cockpit theme the unique identity of this new mean of transport will be lost which would be a big missed opportunity. And again, this extravagant display would distract too much from the actual experience that should be the main focus of the following study.

The last concept of the support screen has the potential to be easily tweaked to fit the other use cases defined within HorizonUAM. It offers a unique design with rounded edges without being too distracting from the actual experience. The familiarity to already existing car dashboards will make it easier for the user to navigate while giving enough room to be unique and to fit into the already established air taxi cabin design.

9. PRODUCTION

9.1 MOODBOARD

To get a general idea of the design direction for the dashboard, a moodboard (figure 6) was created. It should represent both the display and the target group.



FIGURE 6: MOODBOARD FOR THE DASHBOARD DESIGN (ALEVISION.CO, 2020; BJORK, 2018; DENIL, 2020; DEUTSCHES ZENTRUM FÜR LUFT- UND RAUMFAHRT, 2020E; FRING, 2020; KOBRUSEVA, 2021; MENTATDGT, 2018; MUZA, 2014; SHAW, 2019; SOARES, 2017; ZHUKOV, 2020).

9.2 STYLESHEET

To keep the style consistent throughout and after the project, a stylesheet was made. The goal was to capture the (initial) uniqueness of this mean of transport. The technical advancement and excitement should be visible in a futuristic design, but it should still be suitable for the business travel audience. Seven different designs were made.

The process started by searching online databases for commercial-free fonts and fonts already used for other projects. Finding suitable resources for commercial-free fonts that were professional and fit the theme was more difficult than expected. Once a sufficient number of fonts were gathered, they were laid out with a short example text on a digital canvas to find pairs that fit together. The focus is laid on sans serif fonts that are neutral, clean, and easy to read. These fonts are also generally considered to be the more modern choice. For the headlines, an effort was made to find a little more expressive fonts to give this display more character and empathize the design goal.

In the next step, colors were collected. To speed things up, different premade color combinations from colorhunt were collected and considered. If additional colors were needed, one color from the preexisting combinations was chosen and placed into the Adobe Color online tool to find new ideas from the different modes they offer.

Different colors were used for different designs, but blue was the preferred color choice, due to its attributes of being calming, reliable, stable, and trustworthy. Over the last years, it also got associated with electric mobility (personal observation). In addition, the color blue was frequently used in the history of aviation, a tradition the DLR would like to continue (A. Papenfuß, personal communication, March 29, 2022). It is also the color of the sky, which can be seen through the windows of the cabin. If the color of the sky is considered to be part of the color theme visible within the cabin, also choosing blue for the dashboard UI does not raise the number of colors visible within the cabin.

But black and white are suitable choices, too. Black is associated with power and seriousness, luxury and elegance. White is a neutral color that evokes the feeling of cleanness and freshness, all things that were wished in the focus group study.

Due to the current trend for dark mode on UI designs, both a light and a dark theme were created for each style idea.



FIGURE 7: THE STYLESHEET CHOSEN BY THE TEAM

Out of the stylesheets, the design concept called “Mono Space” (figure 7) was the preferred option for the team. The others, with a short explanation, can be found in Annex B: Stylesheets.

9.3 SKETCHES

Since the general style of the UI was set, it was time to generate ideas for the general layout. To stay fast and flexible, all of these sketches were done by hand on paper. The first sketches expressed ideas for the “low information” design. These feature only the arrival time and the service call button, and a screen that indicates that the service call is in progress.

These sketches were followed by ideas for the “high information” design. To keep the information legible, it was decided to split the information into two screens and the additional service call screen. To switch between the different screens, the user has to press the fitting button. In most iterations, they were styled like tabs. It was experimented with the placement of the different tabs and information (Figure 8).

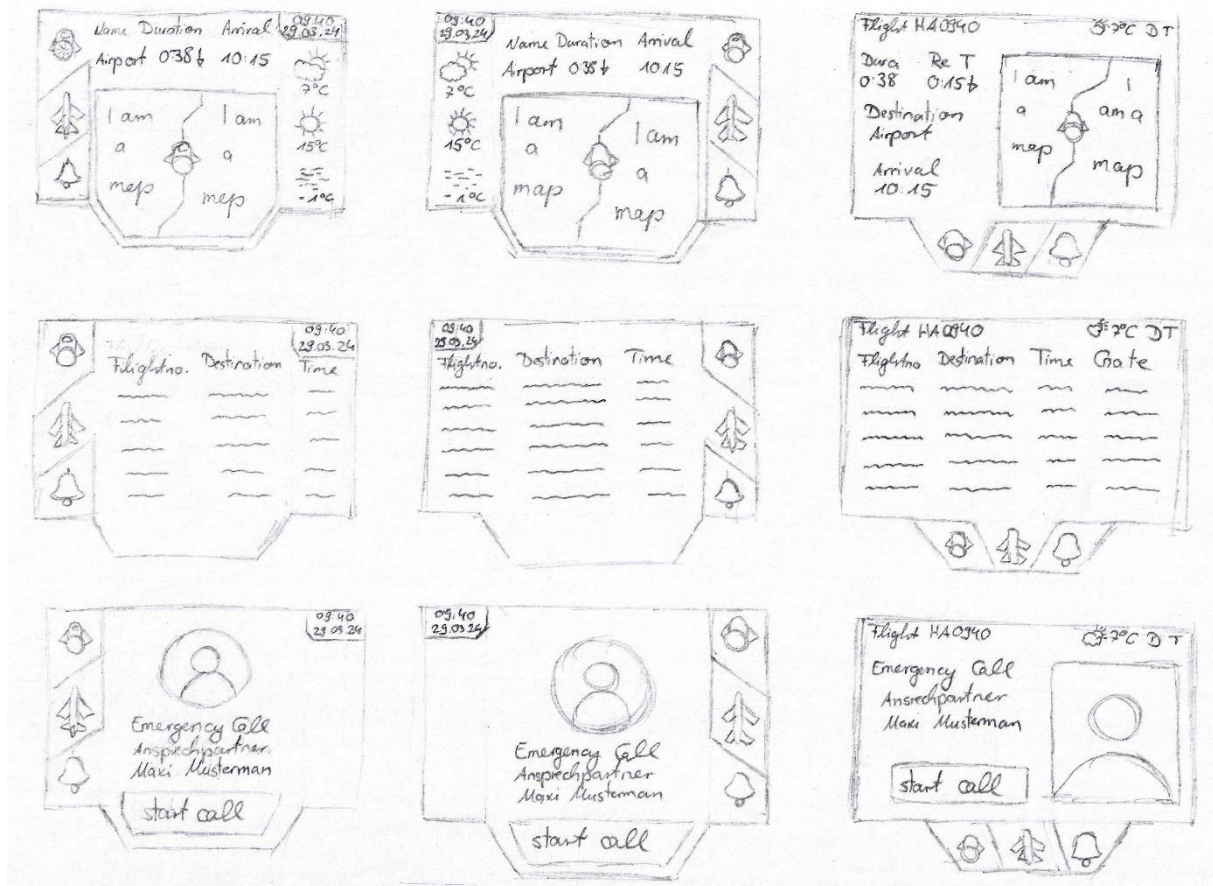


FIGURE 8: SKETCHES OF THE DIFFERENT PLACEMENT OF THE TABS

After a meeting with the researcher who will be in charge of the study to get feedback, it was suggested to try and fit all information on one screen. Sketches for that were made, too (figure 9).

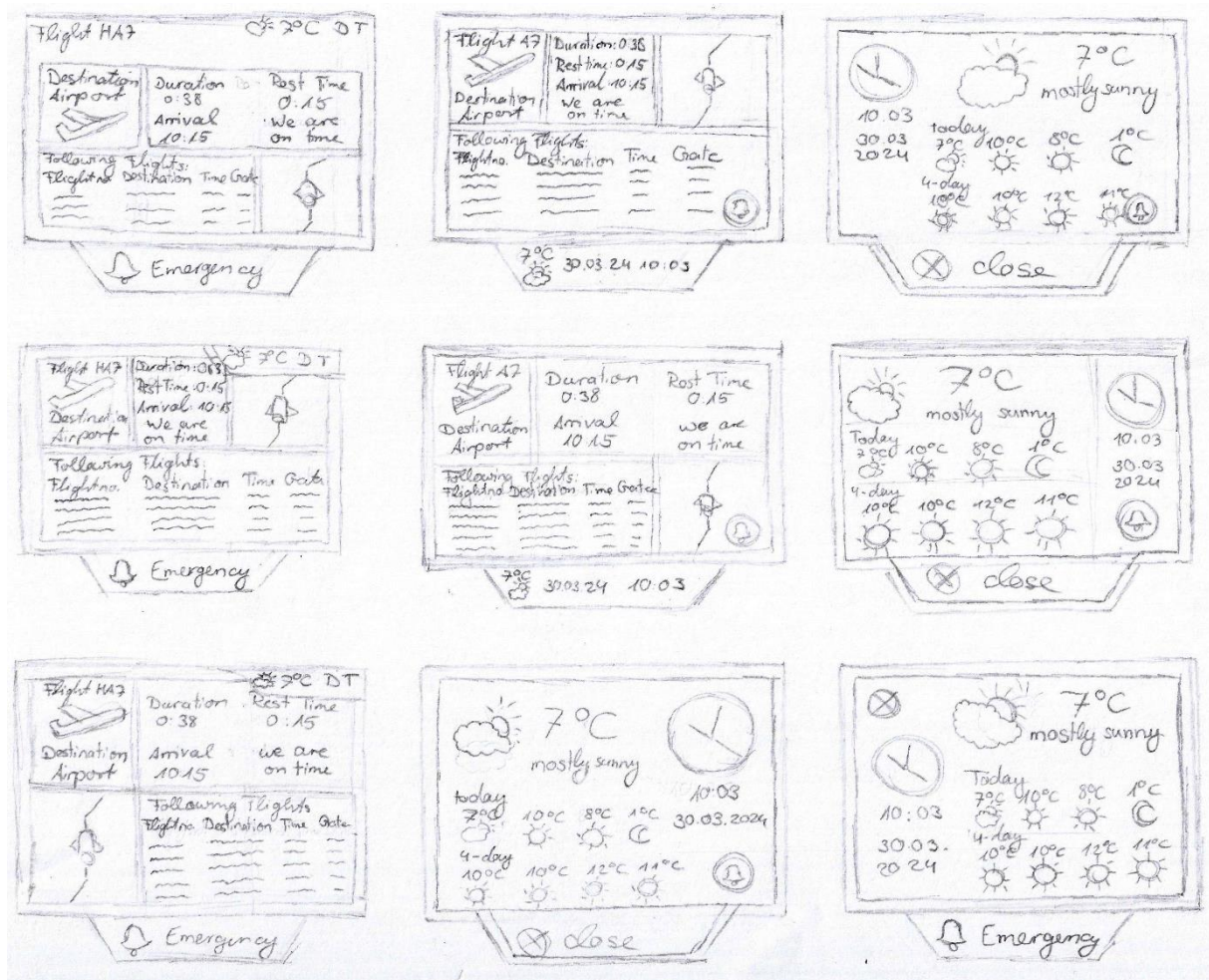


FIGURE 9: SKETCHES BASED ON THE FEEDBACK OF THE RESERACHER

Afterwards, the sketches were scanned and the favored designs for each idea were placed into InVision to create a first prototype. Additional sketches can be found in Annex C: Sketches.

9.4 INVISION PROTOTYPE

To make sure everybody in the team has the same idea of what is going to be created and how it should work, a quick prototype was created in InVision (Vieler, 2022a, 2022b). It made use of the sketches produced in the step described in 9.3 Sketches. Only basic functionality was added to convey the idea.

The first one was created to show the functionality of the “high information” screen with the tabs. The second one should show all the information on one screen, as requested by the researcher. Hotspots were created over the tabs, so the user could click through it and see all the screens available without much more interactivity. A timer was set that would trigger the accident screen after three minutes of inactivity.

It was decided that the version requested by the researcher was too cramped. The information needs enough space so it can be read more easily, without much additional effort by the user. In addition, the team would like to have an additional overview screen, where the most important information can be seen. For more in-depth information, the user can click on the tabs and go to another page.

9.5 CREATING THE SCREENS

After deciding on a design direction, the next step was to create designs in higher fidelity, that can actually be used in the simulator. Due to having no prior experience with the SVG-data format, a short research sprint was done with the goal to understand the basics of the format and think of a suitable workflow.

SVG or scalable vector graphics is a file format that produces graphics based on vectors, not pixels like bitmap formats like PNG-files (Karlins, 2018b). This means a bitmap-file has set instructions for every pixel in the picture, while an SVG-file has the instructions to calculate graphics based on anchor points, like graphs in a coordinate system (Powell, 2018). This advantage makes it quite easy to change properties with code and keeps the file-sizes small (Elegant Themes, 2020). It is the only vector graphics format that is supported by internet browsers which makes it popular for the use of graphics in websites (Mozilla Corporation [Mozilla Hacks], 2018). Especially logo designers like to work in this format (Karlins, 2018a; Powell, 2018).

Due to familiarity, Adobe Illustrator was used to create the designs. To get a base and a quick first result, the first screen that was created was a service call screen and a few iterations. Based on that, a "low information" service call screen and a screen with only the arrival time were created, already with several iterations. In the following days, designs and iterations of the main air taxi information screen, following flights, and another service call screen with more information were created.

All files used the same base. Then all decorative elements and icons were created. First, a basic shape (usually a square) was placed on the canvas, and then additional anchor points were added to the outline. These anchor points were moved around until the desired shape was achieved. In the end, all text was placed. The placement of all elements was determined by a phi-grid, symmetry and proximity rules or invisible lines. Groups were created by proximity to each other. Similarity was created by font and alignment. If a symmetry axis was drawn in the middle of the screen, it was important that the weight of the design was equally divided on both sides. In consideration of Fitts' law, the main information in the middle of the screen was designed bigger than the rest of the text. To follow Hick's law, the required information was presented as short as possible and only available if the right tab is pressed. The call button is placed on the lower right side of the display. Since the tester will sit on the right side of the taxi, the important information is placed on the right side of the screen, too. This way it should be easier for the tester to see. Pictures, maps, and bigger information are placed on the left. To make the design appeal to the western way of reading, the information is always structured from the top to the bottom of the page. The most important information was placed towards the top left, following the Z-layout. An example of the used design principles on the actual screen can be seen in figure 10. The cyan lines indicate the phi-grid, red lines are symmetry axes. Yellow boxes indicate the proximity rule, green lines are invisible lines. Magenta is used for the Z-layout. Additional design methods, like googles material design principles, were researched but not used since they did not contribute anything to the design.

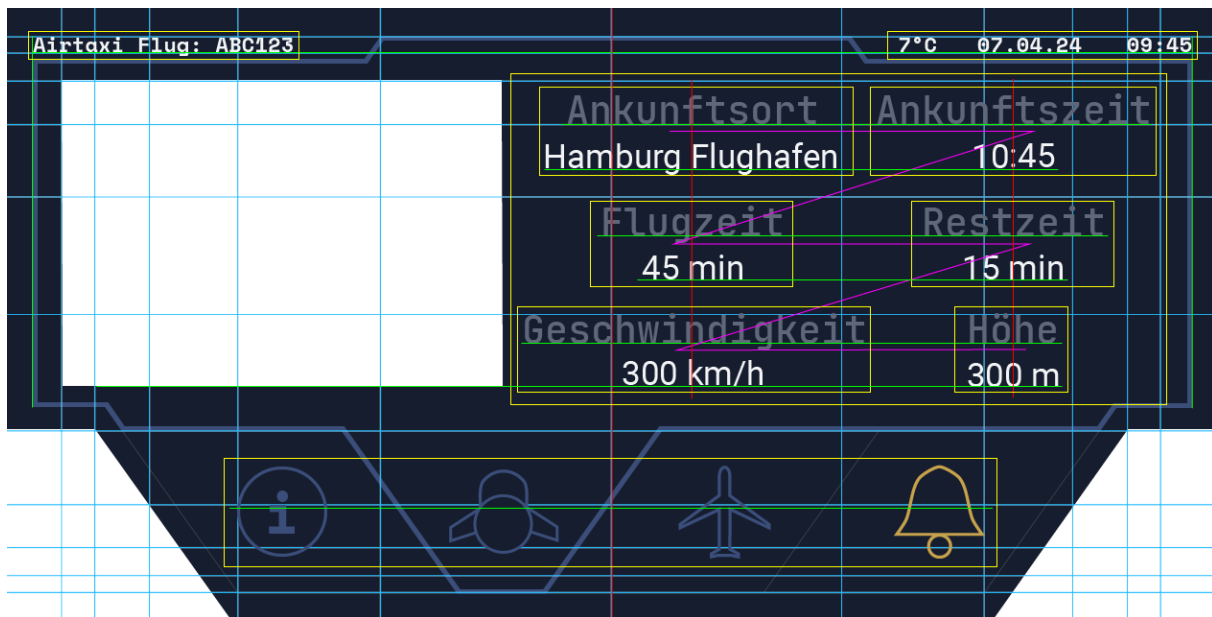


FIGURE 10: DESIGN RULES USED WHILE DESIGNING ONE OF THE DISPLAY PAGES

The decision to use Adobe Illustrator should have had a major decrease in production time. But it also caused major issues. One issue with no obvious fix is that Illustrator offers no option to add attributes directly to the XML-tree of an SVG-file like the open-source competitor software Inkscape. Therefore, there is no direct way to add classes to the file. Classes are a requirement since the code framework needs them to live update the changing values later. The only attributes that can be directly influenced by the designer are IDs, which can be changed based on the layer names. Depending on the export options Illustrator creates classes itself, but these classes are only there to determine style attributes like fonts and color. Every element can only have one class.

To generate the right classes anyway, the exported SVG was opened in Inkscape to add the classes manually. The export is a necessary in-between step, since Inkscape does not natively support EPS-files and treats AI-files like bitmap-based PDFs and therefore deletes all vector information.

To determine the size of the canvas, the actual physical dashboard was measured and then the values were put into Illustrator. Then, the units were changed into pixels. This caused every vector point to get very odd values, which would make it unnecessarily complicated to work within the already established workflow of the programming department.

Another problem is that Illustrator generates lots of unnecessary data in the files, which is also not favored by programmers.

All of these issues combined led to the conclusion that Illustrator is actually not suitable for creating files that meet the requirements. A base SVG-file with already working interaction code was provided. In this file, one of the design iterations was recreated and the right attributes were attached, all done in Inkscape. Some changes were made to make it more intuitive or better understandable.

10. TESTING

After a proper and working test file was created, preparation for a usability test began. This was more stressful than expected since the news of the possibility to test properly came rather spontaneous. It was not expected to be part of a pre-study before the actual study in July 2022. The testing period of the pre-study was between May 12, 2022 and May 20, 2022.

10.1 TEST GOALS

The goal of this pre-study was to find out which simulator set-up is the most suitable for the study in July. For the UI, this opportunity has been used to perform a usability test and an interview. The objectives of this test were to ensure the design choices are fitting to and accepted by the target audience, to find out if all the elements are legible in a mixed reality environment, and if the functionality is intuitive.

10.2 TEST METHODOLOGY

10.2.1 PARTICIPANTS

The number of participants was 12, three women and nine men, with a medium age of 35,25 years. All of them work for the DLR and were recruited via e-mail, phone call, or personal communication. Since every aspect of the air taxi is new to everybody not directly involved with this project, no prior knowledge is needed. Experience with touch screens is recommended, but not needed. The same applies to experience with business trips.

10.2.2 FORMAT AND SETTING

The pre-study took place in DLR's air taxi simulator in Braunschweig. This is where the cabin simulator is located. In addition to the cabin, the mixed-reality glasses Varjo XR-3 and a Microsoft Surface Windows Tablet will be used. The participant has to evaluate different mixed reality setups. The first setup was a virtual world outside of the cabin, the cabin itself and everything inside it will be visible through the glasses. The UI will be displayed on the tablet (figure 11). The second setup is not so different from the first one. The only difference was that in this setup a mask will make the hands of the participants visible if they hold them in front of the virtual elements. This setup was only used in the second scenario, which will be explained later. The third setup was a mixed presentation. In addition to the virtual scenery, virtual elements like chairs were visible inside the taxi. The UI was completely virtual, too. The last set-up was a complete virtual setup. The display was shown virtually, as well (figure 12). The participant stayed inside the cabin, so they would get haptic feedback if they try to touch the display.

These four setups were tested in two scenarios. In the first scenario, the air taxi stayed static on the vertiport. The participant was looking around and had to solve simple math questions that were displayed before them. In this way, buttons, sliders, and font sizes were tested with a separate display. In between every set-up, a questionnaire with the same questions was answered by the participants. At the end of this scenario, a new questionnaire was answered.

After a break, the four setups were tested in the second scenario. This time, the air taxi flew for a short distance. The participant was asked to look around and interact with the dashboard. This was the moment where the functionality test took place. The participants were monitored by the author of this report, who took notes. Again, after every setup change, the participant had to answer a questionnaire. In the end, the participants had to answer a different questionnaire again. After that, they were interviewed about the design by the author. They had to answer nine questions.

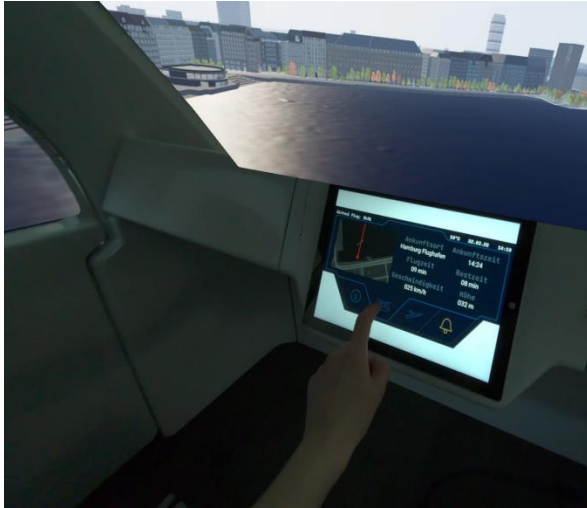


FIGURE 11: UI DISPLAYED ON THE TABLET (SETUP 1)

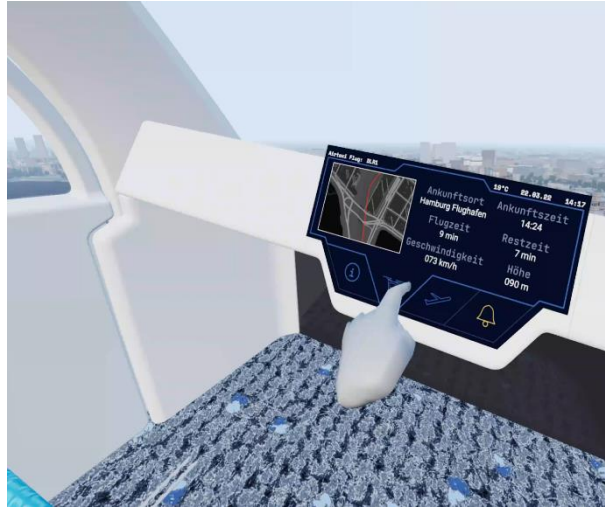


FIGURE 12: UI IN THE FULL VIRTUEL CABIN (SETUP 4)

10.3 INTERVIEW

The interview took part after the functionality test. The advantage of an interview compared to a normal questionnaire is that after long test sessions like this, the participant is more likely to answer more detailed verbally than by writing it down on paper (J. Ernst, personal communication, May 03, 2022). If they are tired, it is easier than writing.

The interview recorded the thoughts of the participant. It generated first insights into the first impression of the design. It created a base to evaluate the following design iterations. In this way, feedback about clarity and readability was gathered. It also became clear if additional information is needed or if everything is already included in the design.

The questions were a mix of closed and open questions. The close questions made it easier to generate solid numerical data. The open questions helped to gain insight into the thoughts and feelings of the user. The order of the question used the FFWD system (Frustrating Favorite Wanted Wand Doing Describe) as an orientation (Patton, 2017). By starting with the questions about problems the user encountered, they will get the negative feelings out of their system and are more positive during the rest of the interview (L. Picker, personal communication, April 28, 2022).

10.3.1 INTERVIEW QUESTIONS

1. Have you encountered any problems while interacting with the display? If yes, please describe them below.
2. Was it possible for you to read every display element without effort? If no, please describe the difficulties you had.
3. Please describe your first impression of the design.
4. Please name three to five adjectives you connect with the design.
5. Which icons can you remember? Please tell me their meaning.
6. Does the design of the display match the design of the whole cabin?
7. Has there been information missing, in your opinion? If so, what information is missing?
8. Which information would be the most important one to make you feel safe in the air taxi?
9. Please give the display a grade from 1 to 6. One is the best, six is the worst.

10.4 USABILITY TASKS

10.4.1 TASK 1 – SERVICE CALL

TABLE 2: USABILITY TASK 1

Goal/Output:	Made a service call
Inputs:	None
Assumptions:	Something happened that requires human assistance, the service call screen is not selected.
Steps:	1. Press on the bell-tab 2. Press the "start service call"-button
Success criteria:	"start service call"-button is pressed successfully
Notes:	

10.4.2 TASK 2 – TAKE-OFF TIME

TABLE 3: USABILITY TASK 2

Goal/Output:	Found and read the right the time of a connection flight (Zürich)
Inputs:	None
Assumptions:	The passenger wants to check if their connection flight is still on time, the connection flights screen is not selected.
Steps:	1. Press on the airplane-tab 2. Read the right information from the table
Success criteria:	The user found the take-off time of flight LX 1051 Zürich
Notes:	

10.4.3 TASK 3 – ARRIVAL TIME

TABLE 4: USABILITY TASK 3

Goal/Output:	Found the arrival time of the air taxi at the airport
Inputs:	None
Assumptions:	The passenger wants to know when their air taxi flight arrives, the air taxi information screen is not selected.
Steps:	1. Press the air taxi-tab 2. Read the right information on the display
Success criteria:	The user found the arrival time of the air taxi

Notes:	
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10.4.4 TASK 4 – DATE

TABLE 5: USABILITY TASK 4

Goal/Output:	Found the current date on the display
Inputs:	None
Assumptions:	None
Steps:	1. Look for the date on the display
Success criteria:	The passenger found the date on the display in the upper right corner
Notes:	

10.5 TEST RESULTS

All testers had a positive response to the display. The design matched or even exceeded the expectations the participants had towards an air taxi display. It was considered clean, self-explanatory, and matched the assignment. The color contrast was particularly well received. It was nice to look at but not too distracting from the actual flight experience. The tabs had the right size. 42% of the testers had interaction issues (figure 13), though. The main complaint was that the tabs do not react immediately once they were pressed.

None of the testers had big issues regarding legibility (figure 14). There was only one complaint that the font on the first screen was too small in one of the dynamic tests. On the other hand, there was one complaint that the text was too big. What affected the readability the most was if the display was virtual or if it was shown on the tablet, which the tester then saw through the cameras in front of the mixed reality glasses.

1. HAVE YOU ENCOUNTERED ANY PROBLEMS WHILE INTERACTING WITH THE DISPLAY?

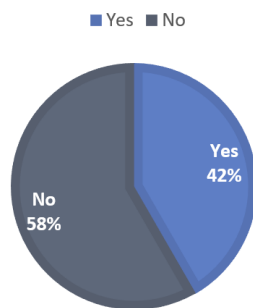


FIGURE 13: VISUAL REPRESENTATION OF THE RESULTS OF QUESTION 1

2. WAS IT POSSIBLE FOR YOU TO READ EVERY DISPLAY ELEMENT WITHOUT EFFORT?

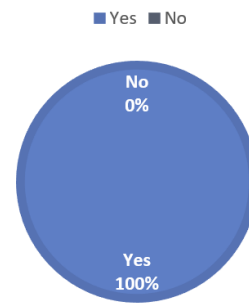


FIGURE 14: VISUAL REPRESENTATION OF THE RESULTS OF QUESTION 2

The most common adjectives to describe the display were “intuitive”, “clean”, “futuristic”, “readable”, and “modern”. The overall theme of all answers described the display as structured and efficient, minimalistic and matching the rest of the concept.

Almost all of the participants remembered that there were four icons at the bottom of the screen and that the icons were logically chosen. When asked about them in more detail, the participants tend to mix them up or forget one. The icons that made the most trouble were the information “i” and the service call bell. Most of them connected the “i” with the service call and then forgot about the bell altogether. One tester said there was a telephone receiver instead of a bell. Multiple testers identified the air taxi icon as a helicopter. But despite all that difficulty, the content of all the pages was mostly remembered correctly. The information that was forgotten the most was on the very first screen.

92% of all testers thought the display matched the overall design of the cabin (figure 15). Only one tester said it did not match with the chairs and carpet.

As seen in figure 16, 75% of the participants thought no important information was missing. The other 25% were looking for safety-related information like a master warning light or other emergency protocols. The calling function, a position indicator, and a light that indicates that everything is all right were the most appreciated features. The most requested addition would be a map of the airport, with indications of where the passengers would arrive and where they need to go. Entertainment in form of newspapers or games was also mentioned, as well as a proper position indicator on the map that was already incorporated into the display.

**6. DOES THE DESIGN OF THE
DISPLAY MATCH THE DESIGN OF
THE WHOLE CABIN?**

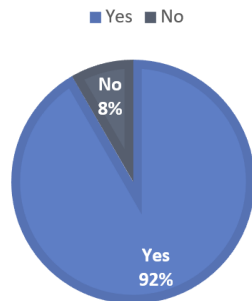


FIGURE 15: VISUAL REPRESENTATION OF THE RESULTS OF QUESTION 6

**7. HAS THERE BEEN
INFORMATION MISSING,
IN YOUR OPINION?**

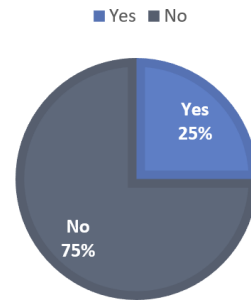


FIGURE 16: VISUAL REPRESENTATION OF THE RESULTS OF QUESTION 7

During the test, it was observed that almost all of the testers would not have interacted with the display without an explicit invitation. Some were not even aware that it was interactable. Others asked for permission before interacting with it. Most of the testers just spend their time looking outside and barely clicking through the tabs on the display, especially in the later set-ups. Once they discovered the call button, all of them made a call without problems. Some tried to interact with the map that was already on the display. The testers tried to zoom out or swipe around.

No problems occurred while the testers completed the user tasks. Only one person said she got distracted from the overall flight experience. The complete German test results can be found in Annex F: Test Results Questionnaire.

11. CONCLUSION AND DISCUSSION

During the test, an interaction issue was discovered. This issue occurs when the participants hit the icon outline directly while touching the button. In the XML-tree of the SVG-file, the attributes that make the interaction possible are attached to the flat plane under the icon, and not the icons themselves. The icons are lying on top of the interaction triggers in the hierarchy. Therefore, the outlines of the icon are blocking the user from triggering the tab switching, if the user is pressing on the icon pixel-perfect. This should not be great problem to fix.

The testers having no problems reading the text means that the text has the right size. So, it can be continued to work with the prototype.

The adjectives chosen to describe the overall design direction were futuristic and minimalistic which was one of the goals. However, since none of the testers mentioned any adjectives that would connect to a more business and professional-like impression, it can be assumed that the design did not directly meet that goal. It should be taken into account that the testers were never directly asked if they could see the design in a business-like environment and generally speaking, they were all satisfied with the design and how it fits into the cabin.

That the icons got mixed up or forgotten, but not the actual information behind it can be explained. Both the first and last tab had no special user task assigned and therefore were not pressed as often as the other two. The fact that two of the testers remembered a helicopter instead of an air taxi icon might be explainable by the fact that there is no established air taxi symbol that is present in the daily life of the participants. A helicopter is more likely to be observed than an air taxi at the moment. But incorrectly remembering icons is not necessarily a problem. It is more important that the testers remember the information correctly and can match it with the icons visible on the bottom of the screen once they see them.

75% of the participants did not need additional information on the screen. That can lead to the assumption that those 75% think that not more displayable information is needed to increase their feeling of safety. But this should only be seen as an indication. It should be discussed if they felt safe because the information is actually enough or if they only felt safe because this is a simulation and they knew nothing could happen to them. The air taxi they used was in a room and did not move at all during the test. Studies with real and flying taxis are needed to see how the testers' perception of safety changes. The current results also give no insights into how passengers would feel in a real emergency or bad weather conditions.

The other 25% of participants gave recommendations on what information might be missing. Those recommendations should be considered when deciding on what else is needed to make passengers feel safer. The most popular suggestion was a light that indicates that the air taxi is functioning normally. This simple light would make a good addition, since it is just a small, cheap piece that can be placed everywhere in the air taxi, while giving the clear indication that everything is all right. But giving a definitive answer on what would be helpful is difficult, since safety can be experienced differently.

Since the testers tried to interact with the map, it can be safe to assume that the displayed section on the map was too small and not the information the testers expected from the map.

Most of the users did not interact a lot with the display during the flight, which means it did not distract them. From the point of view of a researcher, who is planning the next study, this is great news. Since the next study wants to get a general impression of an air taxi flight, it is important that the test participant will not get too distracted by the display and can give feedback about the whole experience. In the actual use case, once this is an established mean of transportation, it does not actually matter if the passenger is distracted or not. The passenger is not in the situation where they need to concentrate on their surroundings, since they are not the person piloting the air taxi. The passenger has no responsibility during the flight.

Since there is not a lot of pre-existing data that would allow for comparison, it can be questioned how plausible this first test actually is. In addition to that, the test participants were interviewed by the creator of the display herself, so the positive response to the design could just very well mean that they were trying not to hurt her feelings. It should also be taken into account that the limited participant number of twelve people is too small to make general claims.

Overall it is safe to say that the project was a success. The display got implemented in the simulator and once the interaction issues are removed it is fully functional. The information is understandable in the way it got presented and 11 out of 12 testers think the display matches the design concept of the cabin.

12. RECOMMENDATIONS

12.1 RECOMMENDATIONS REGARDING THE PRODUCT

42% of all testers complained about interaction problems while pressing on the tabs. Adding the icons to the same group as the planes, that have the attributes for the interaction attached, should solve the issue.

Adding a physical service call button would also be recommended. In case of a broken or malfunctioning touchscreen, the user should still have the option to call the air taxi support if a problem occurs. If the physical button does not start a call, it should at least send a distress signal. This button can malfunction, as well, but by having two systems in the cabin, one can function as backup. It would add to the feeling of safety, as well as adding a physical light that indicates that the air taxi functions normally. A small LED light, that glows green during the complete flight would meet the wishes of the test participants without much more additional costs. This light should also be physically outside of the digital display, so in case of a malfunctioning display, the light can still give the indication that everything else is working properly. It should also be considered to add proper safety instructions once they are defined. Knowing how to behave in an emergency, knowing there is a plan, would also increase the feeling of safety.

Some testers complained about the readability of the display when it was displayed on the tablet. To avoid this, it would be recommended present the display as a virtual asset in mixed reality.

Due to the overall positive feedback on the design concept, it does not need to be changed for the main study. Inviting participants that have a lot of experience with business travel is advised, though, to get their feedback as well.

The icons on the tabs should not be changed. Even though the air taxi got identified wrong multiple times, the main reason behind that is that there is no air taxi icon established, yet. Since the association between the service bell in an elevator and the service call function was not obvious, it is worth considering if discarding the bell icon and replacing it with the “information i”-icon to underline its service qualities might be the better option. The golden color should be kept, though, so it stands out next to the other icons in an emergency.

On the first page, the only relevant information is the indication whether the air taxi is on the ground or not. It should be questioned if this information can be placed on the second page and if this first page can be deleted altogether because it is not adding any value otherwise.

Adding an indication icon on the already implemented map on where the air taxi really is, placing the indicator more to the bottom of the screen, and zooming out the shown section of the map will add user-friendliness. In this way, the user can understand their surroundings better and prepare for what comes next. To prepare the user for their stay at the airport, a map of the location with indicators of where to go next or where the bathrooms are should be added, too.

Entertainment, news, and additional tourist information should be added as a long-term goal for the display.

Since inclusion was an important factor for everybody involved in this project, the display should be tested with visually impaired individuals, too. The best methods and functionality for blind people should be researched, implemented, and tested as well. Based on the results, the display concept needs to be improved. It would also be advised to test the whole concept with physically impaired individuals and elderly, to make sure the cabin is also suitable for these groups of people.

When deciding on hardware for the screen, it is important to test it extensively before building it into a prototype. It needs to work under different extreme weather and temperature conditions. Tesla quite famously had problems with that in their cars (Niedermeyer, 2019).

12.2 RECOMMENDATIONS REGARDING THE PROJECT

During the production, the screen visuals were produced in Adobe Illustrator, which led to the problem of uneven numbers in the SVG-Files. This could have easily been avoided if a conventions document would have been made before production. In there, units, canvas sizes, and other conventions can be established and used throughout the project by everybody involved. Even after people left or new people start to work on it, this document keeps the rules during the production consistent.

There was a lot of effort put into the creation and perfection of the high-fidelity prototypes by the whole team. The testing happened rather late in the development of the whole project. It is worth considering starting to test earlier with prototypes of lower fidelity. In this way, it can be ensured that the project is still on track and get more impressions earlier. It will also save time and money.

During the tests, it became clear that tall people struggle to get in and out of the physical cabin comfortably. These parts of the product should be tested as well, with different kinds of target groups, to find the best fit.

While the direct geometry of the 3D models used in the virtual environment was never visible, it would be recommended to let them be checked again by a professional 3D game artist, to see if they are correctly optimized for a 3D visual reality environment. Several issues with the UV maps were visible during the study. With the correct optimization, the models will get closer to industry standards and performance issues will decrease.

Trying out other project management concepts might also help to increase efficiency in the projects. Some kind of visual representation of what is everybody working on would improve communication if maintained properly. In this way, everybody involved in the project can see who is responsible for what part and does not need to ask around until the right person is found.

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ANNEX A: SWOT ANALYSES

In this Annex, the full SWOT analyses can be found.

1. CONFERENCE TABLE

TABLE 6: SWOT FOR THE CONFERENCE TABLE CONCEPT

Strengths	Weaknesses
- Second screen function - The taxi can be used as a normal workspace - The taxi can be used as a conference space - Clear emphasis on target audience and use case - Unique - Service button is always in view	- Cabin is too small to make a table in it comfortable - Depending on the weather, the projection might be hard to see - Many parts that can break - A real table is often not required to work, a lap is enough for laptops - Placement of the chairs make it uncomfortable to get in and out or just look outside - Even though the service button is always in view, it might be hard to reach for some user groups - Distracting from the actual flight experience
Opportunities	Threads
- Office programs make it possible to work in the cabin even without own devices - Shared office space was a trend before the pandemic - Future proof: once air taxis become the new normal, people might not even want to look outside anymore and prefer to be productive	- External license fees for office programs - It is questionable to find a way to implement the office programs efficiently - Opening work related documents on public devices often is not wanted or even not allowed - Working together in such a small space might not be favorable for hygienic reasons - How interesting/future proof is this design for other target groups in other use cases? - Supply shortages are currently still a problem because of Covid-19

2. AIRPLANE COCKPIT

TABLE 7: SWOT FOR THE AIRPLANE COCKPIT CONCEPT

Strengths	Weaknesses
- The whole dashboard space is used - Unique, attention seeking solution - A lot of space for (personalized) information	- From the back seats, the display is hard to see fully. Not even the middle console is completely visible. - The one end of the display is hard to see when sitting on the other side of the cabin - When a passenger reaches over to drag information to their side, they are immediately in the personal space of the person next to them, might causing an awkward situation - If another person is looking at a certain piece of information, they might get angry if it is dragged over to the other side, causing an unpleasant flight experience - A screen this size needs to be custom made which results in higher production costs - The service button is hard to reach from the back row - The design idea is taking away from the unique identity this new vehicle could have
Opportunities	Threads
- The screen can be used in many different ways, not only in the way of this concept - 2 in 1: in addition to the sensation that is an air taxi flight, many can experience how a plane cockpit looks like	- It cannot be assumed that all users actually understand what the information actually shows or means and therefore becomes actually useless - Sharing one big screen might cause hygienic issues - Supply shortages are currently still a problem because of Covid-19

3. BUSINESS SUPPORT SCREEN

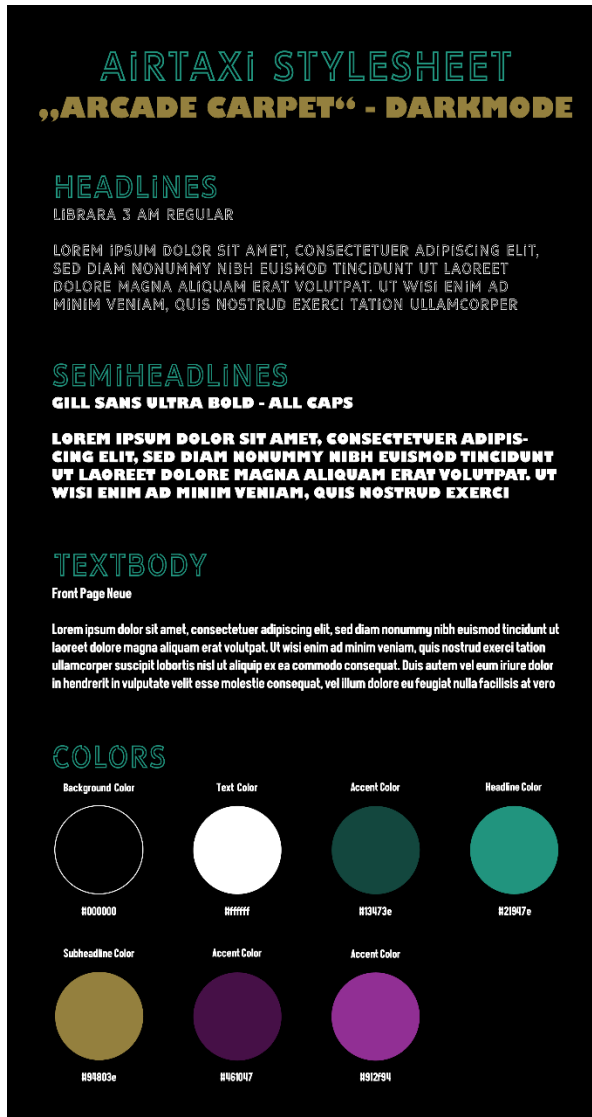
TABLE 8: SWOT FOR THE BUSINESS SUPPORT SCREEN CONCEPT

Strengths	Weaknesses
- Own private screen, no sharing required - Fills out the whole middle part of the dashboard - Unique design choice - Not prominent or distracting enough to take away from the experience - Right information for the right target audience - Strong resemblance to car dashboards	- The unusual screen form results in higher production costs - Not the most original idea - Small and some space needs to be reserved for the service button always - Not enough functions for other target groups or use cases
Opportunities	Threads
- Easy adaptable from a one screen concept into a multiple screens concept - Adaptable for other user groups - Dark mode gaining more and more popularity - High contrasts are a trend seen in other air taxi concepts as well - Rounded edges are heavily used in science fiction designs, there makes a strong connection to "the future is now" - The familiarity to car dashboards makes it easier for the user to interact with it - Wider display ratios like 18:9 are popular on smartphones right now	- The round edges can become a problem with other entertainment later on - Supply shortages are currently still a problem because of Covid-19

ANNEX B: STYLESHEETS

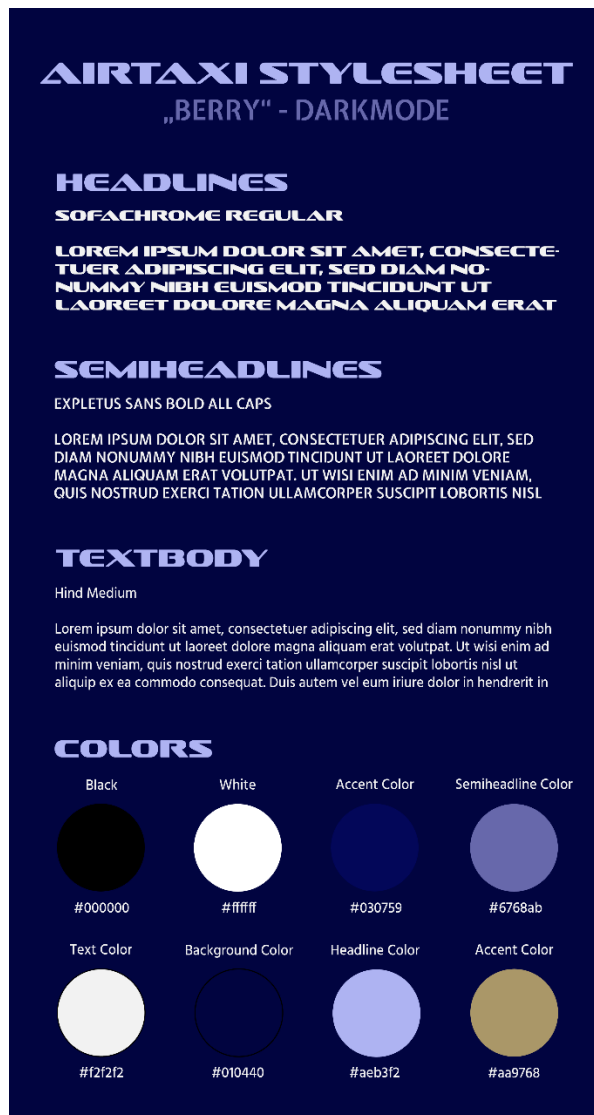
In this Annex, a short explanation of the thought process of each Stylesheet combination will be given.

1. ARCADE CARPET



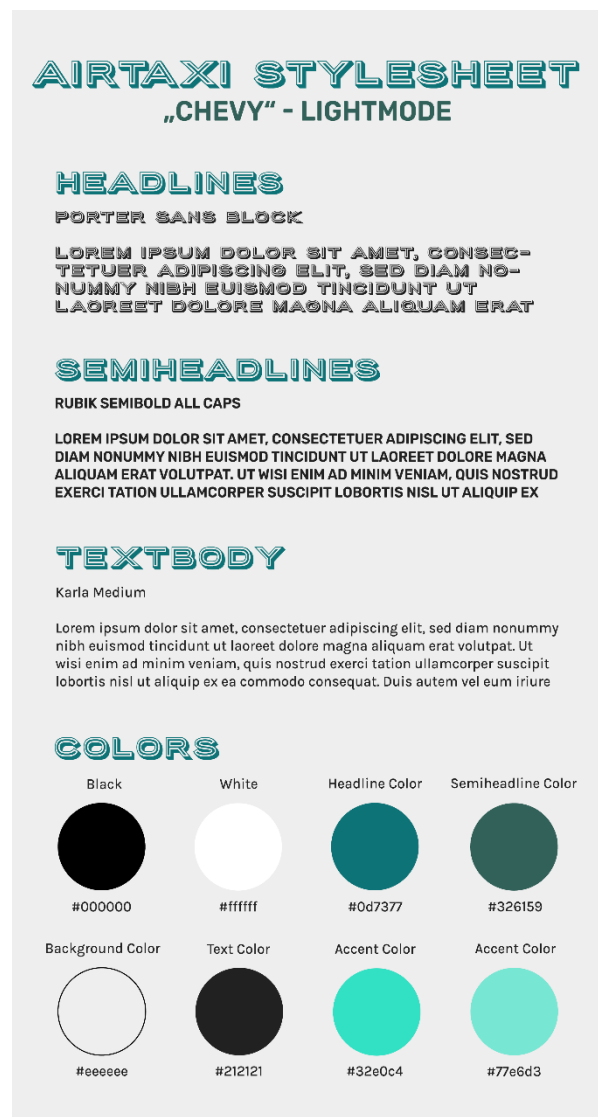
This was not a very serious design proposal but more of an experiment with a more colorful theme.

2. BERRY



This design focuses more on a futuristic, spacy design with the choice of colors and fonts.

3. CHEVY



The idea behind this design was to get even closer to cars and make a connection to the brand image of retro car brands from the 1950s and 1960s. Not an obvious choice for a futuristic technology but nostalgia is a strong feeling that many advertisers currently use to get the attention of the target audience, even if they never experienced that time before (personal observation). The turquoise colors should bring back the futuristic technology to mind.

4. MACHINE



For this design, green was chosen not only to preset a different color solution but also because of its use as a font color for different pc screens in science fiction movies. In this way, a clear connection to the futuristic part of this project is made. The blocky font emphasizes this connection to computer technology. Green also has a connection to environmental awareness.

5. RAINY DAY



With the only serif font used in this entire procedure, the emphasis was here to create a trustworthy and serious design, which might be even a bit too conservative for technology like an air taxi. Therefore, a more expressive headline font was added to break it up.

6. STANLEY



“Form follows function” is not only the approach in which products like this air taxi should be designed, but also the motto of the legendary art and design school Bauhaus. This design inspired by their principles has a clear focus on readability with high contrast primary colors and an easily readable font. It was never considered a serious proposal.

7. MONO SPACE – LIGHTMODE

AIRTAXI STYLESHEET

„MONO SPACE“ - LIGHTMODE

HEADLINES

SPACE MONO BOLD ALL CAPS

LOREM IPSUM DOLOR SIT AMET, CONSECTETUER ADIPISCING ELIT,
SED DIAM NONUMMY NIBH EUISMOD TINCIDUNT UT LAOREET DOLORE
MAGNA ALIQUAM ERAT VOLUTPAT. UT WISI ENIM AD MINIM VENIAM,
QUIS NOSTRUD EXERCI TATION ULLAMCORPER SUSCIPIT LOBORTIS

SEMIHEADLINES

JETBRAINS MONO SEMIBOLD ALL CAPS

LOREM IPSUM DOLOR SIT AMET, CONSECTETUER ADIPISCING ELIT,
SED DIAM NONUMMY NIBH EUISMOD TINCIDUNT UT LAOREET DOLORE
MAGNA ALIQUAM ERAT VOLUTPAT. UT WISI ENIM AD MINIM VENIAM,
QUIS NOSTRUD EXERCI TATION ULLAMCORPER SUSCIPIT LOBORTIS

TEXTBODY

Roboto Regular

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat. Ut wisi enim ad minim veniam, quis nostrud exerci tation ullamcorper suscipit lobortis nisl ut aliquip ex ea commodo consequat. Duis autem vel eum iriure dolor in

COLORS

Black



#000000

White



#ffffff

Headline Color



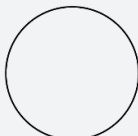
#3b4e7a

Semiheadline Color



#383c47

Background Color



#f1f3f4

Text Color



#161d2e

Accent Color



#5f7fc7

Accent Color

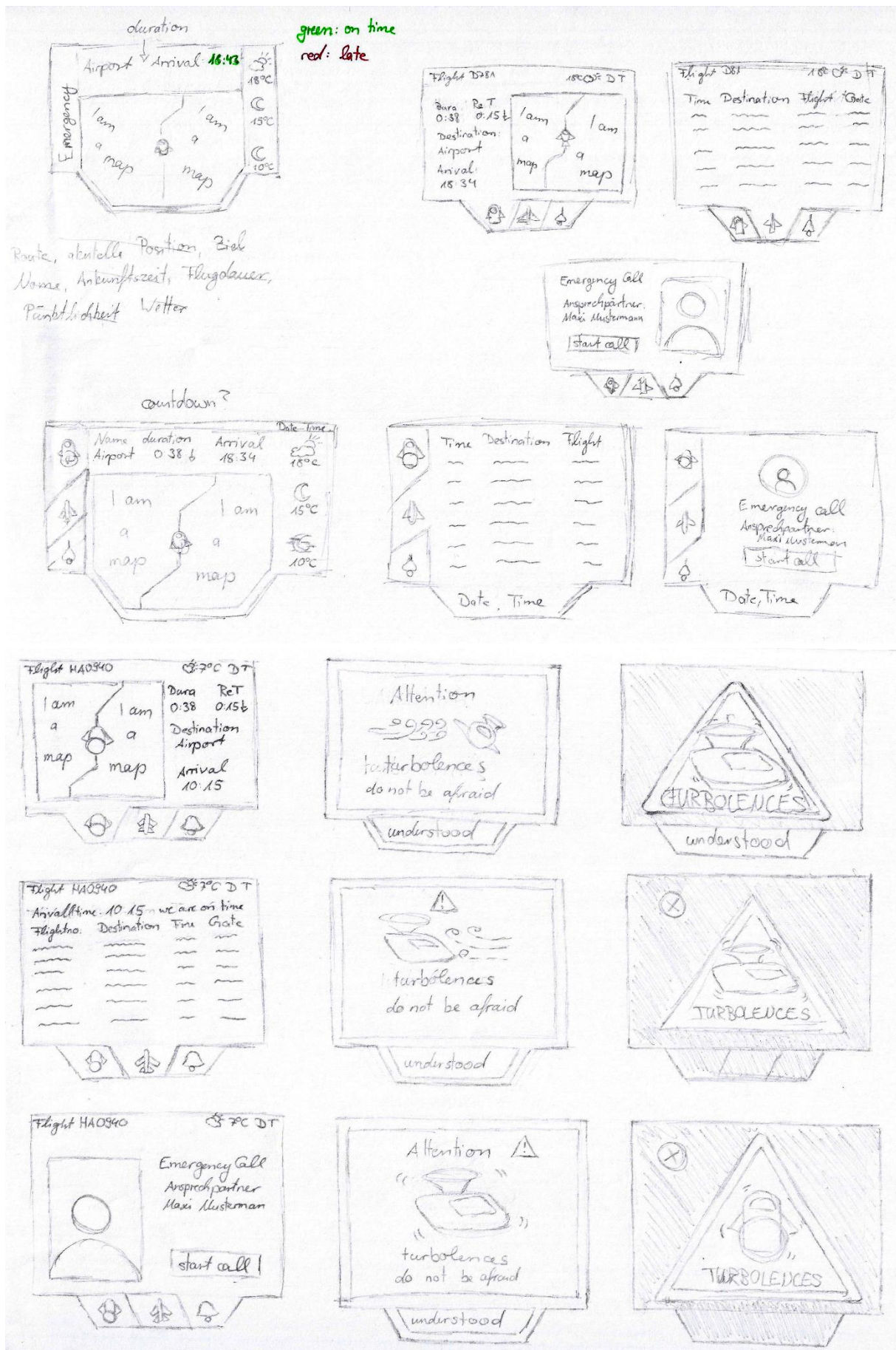


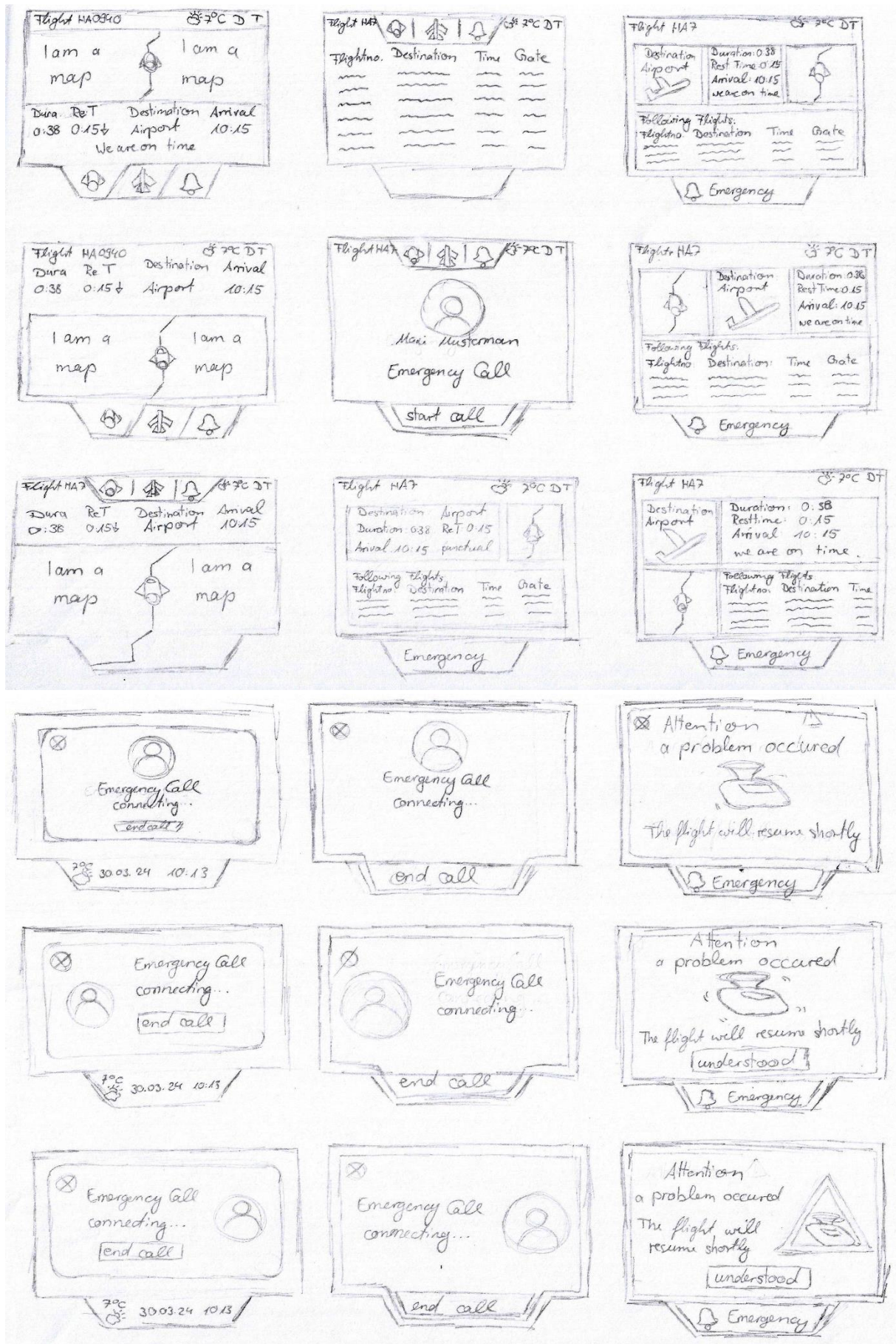
#5f687a

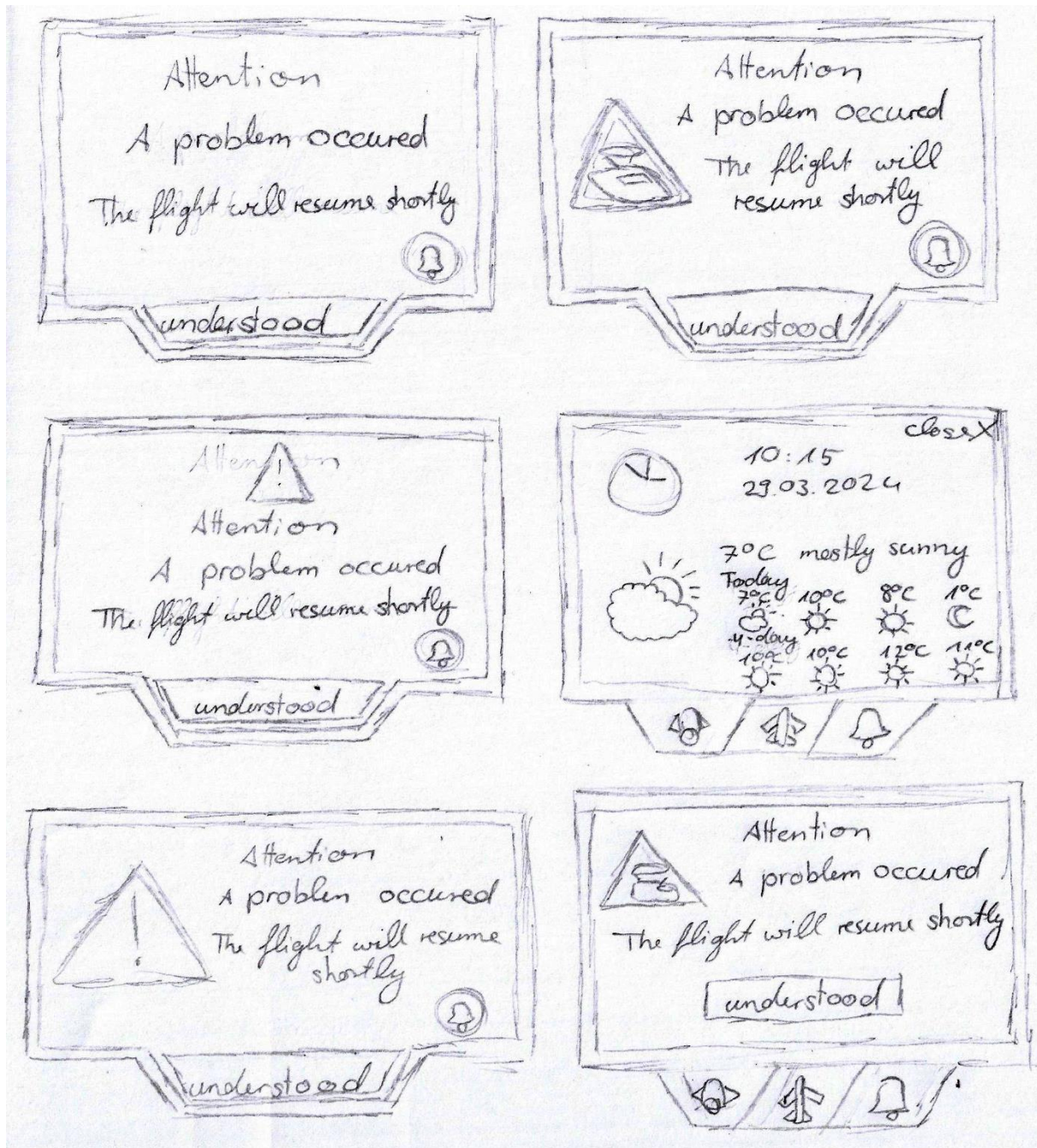
ANNEX C: SKETCHES

In this Annex, additional sketches of the ideas for possible screen designs can be found.









ANNEX D: FINAL PRODUCT

In this annex, screenshots of the final product can be found.

1. HIGH INFORMATION SCREENS

The high information screen shows all of the information required for the study. This was also the display used for the functionality test. The first side is a simple welcome screen with a short introduction. The most important information here is the indicator at the bottom of the screen that changes between “the air taxi is in flight” or “the air taxi is on the ground”, depending on which state is true.



On the second screen, all information regarding the air taxi flight is displayed, such as arrival time, flight time, and remaining time, but the speed and flight height as well. These values can be live updated with the framework.



On the third screen, the next six flights that take off at the destination airport are listed.

Airtaxi Flug: DLR119°C22.03.2214:16

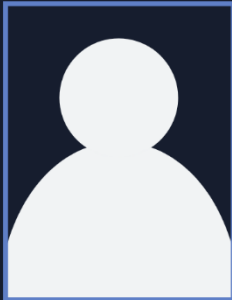
ANSCHLUSSFLÜGE

Flugnr.	Ankunftsort	Zeit	Terminal	Gate
OS 176	Wien (VIE)	15:45	T2	A17
SK 646	Kopenhagen (CPH)	15:45	T2	C11
LX 1051	Zürich (ZRH)	15:45	T2	A18
LH 013	Frankfurt (FRA)	16:00	T2	A20
EW 7582	Palma de Mallorca (PMI)	16:05	T1	A39
EW 7844	Olbia (OLB)	16:10	T1	A46



On the fourth screen, the contact information about the service call is displayed as well as the button that starts the call.

Airtaxi Flug: DLR119°C22.03.2214:16



SERVICE

Ansprechpartner:
Tim Laudien

ANRUF STARTEN



The next screen is triggered once the “start call”-button is pressed. It will set up the connection to the service.



The last screen was not used for the usability test but is required for the study. It is displayed when something unplanned is happening and tells the passenger to call the service.



2. LOW INFORMATION SCREEN

This display version is not tested, yet, but is also needed for the next study. It only shows the bare minimum of information to the participant. On the first screen, only the arrival time and the button to call the service are displayed.



This screen is displayed to let the passenger know that the service call is set up. No more information is displayed.



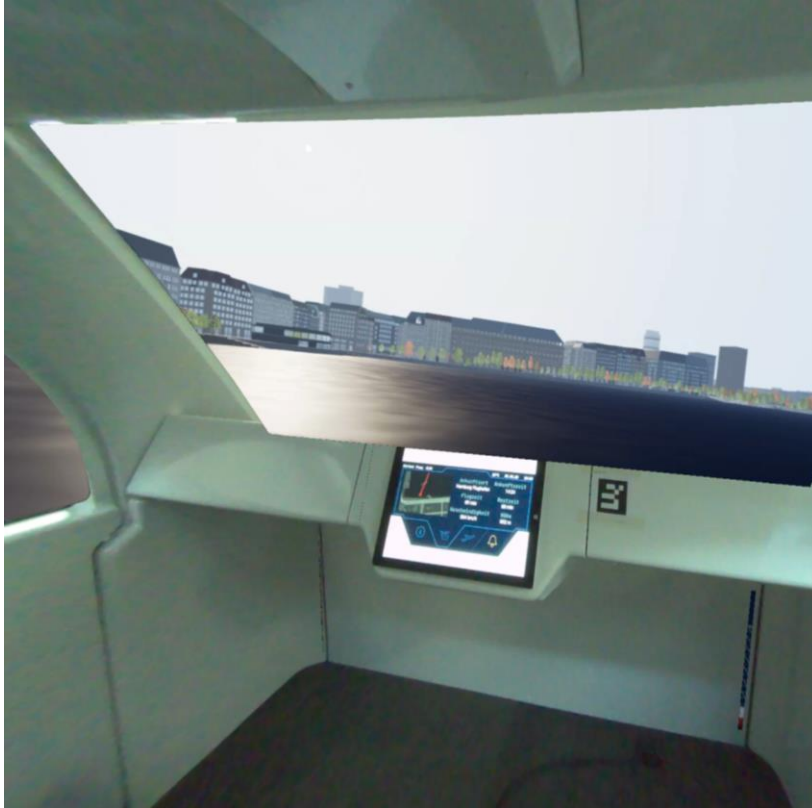
The last screen that can be displayed is an indication that something unplanned happened. The passenger is requested to call the service.

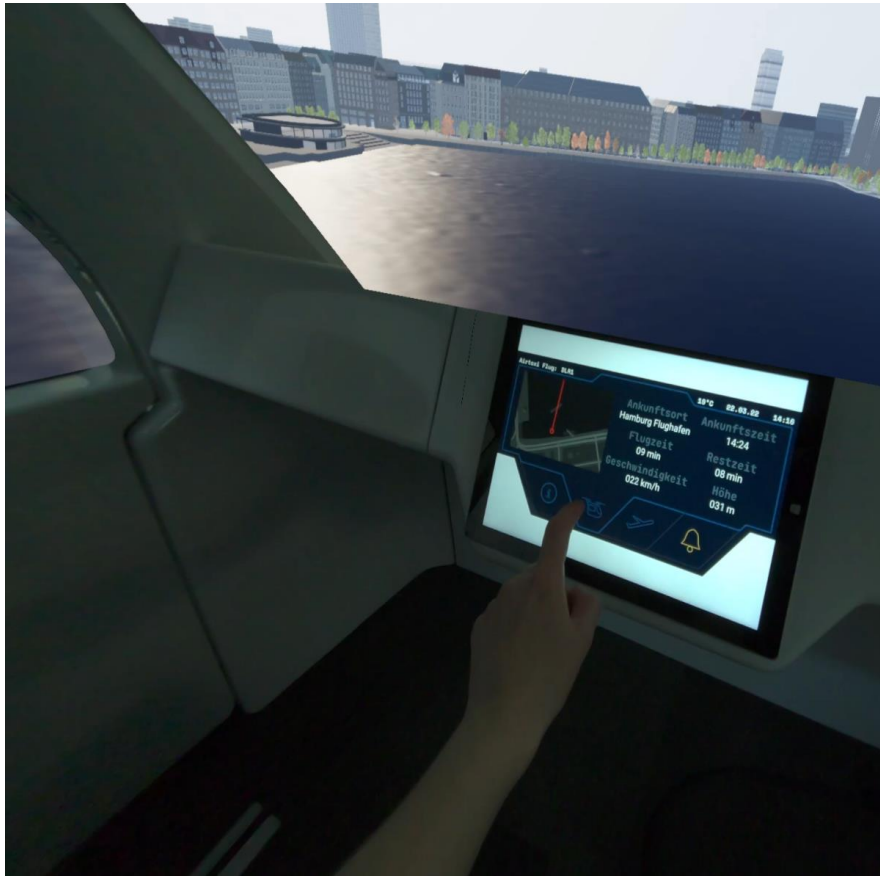


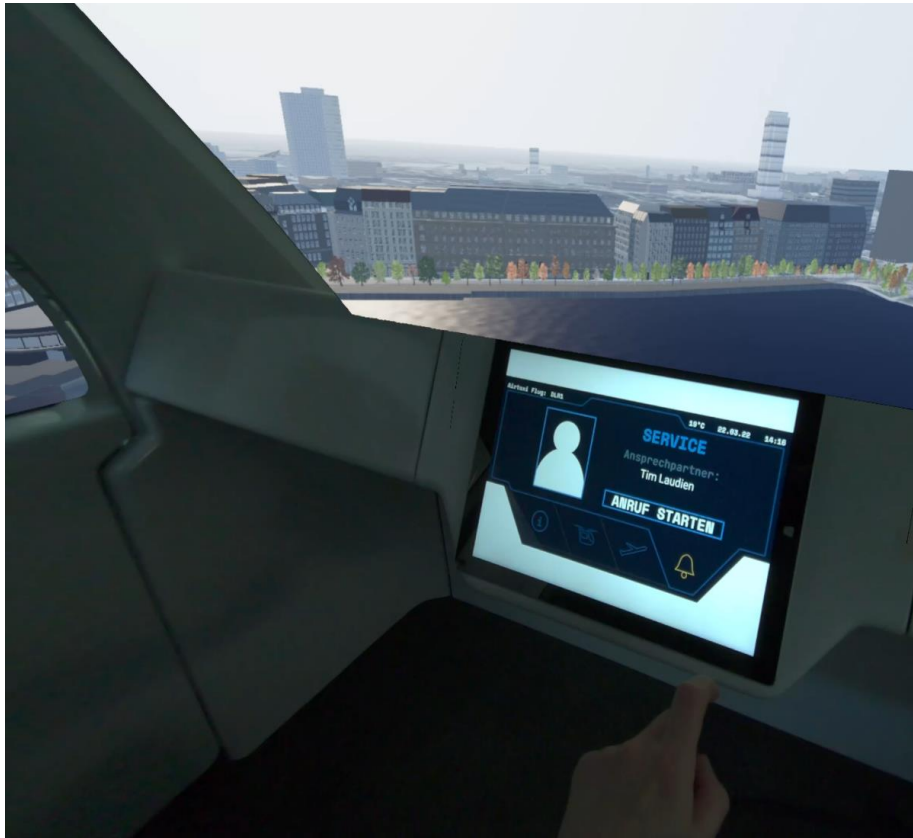
ANNEX E: SCREENSHOTS OF A FLIGHT IN TEST SCENARIO 2

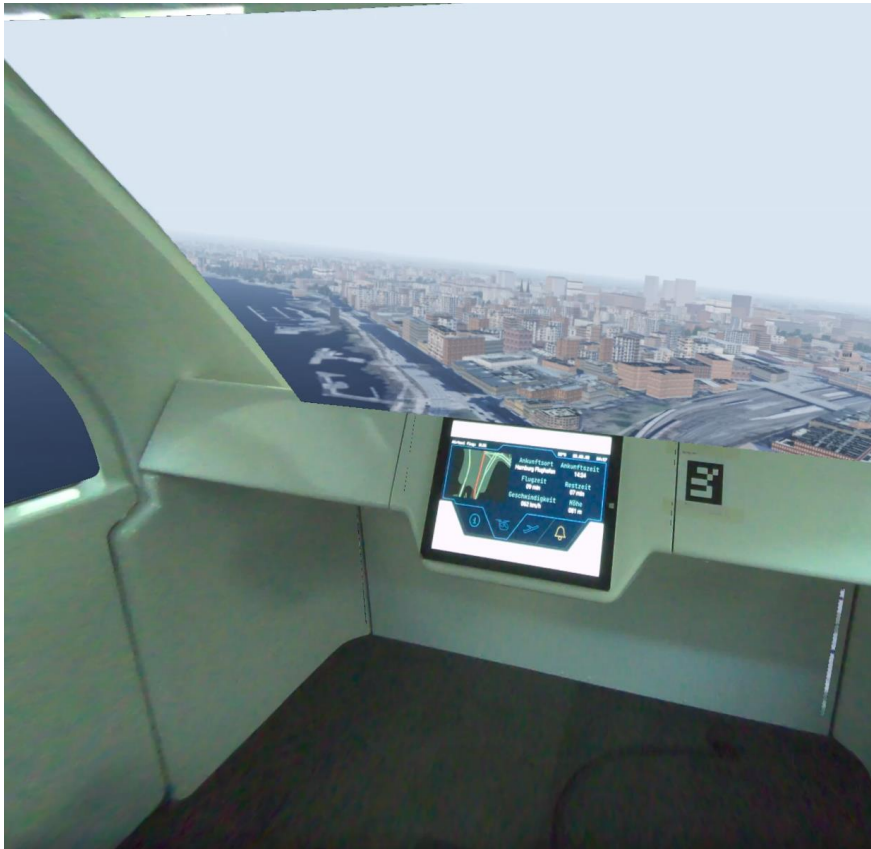
1. SETUP 1

The following screenshots should give an impression of a flight in the simulator during test setup 1 in scenario 2, which is described in chapter 10.



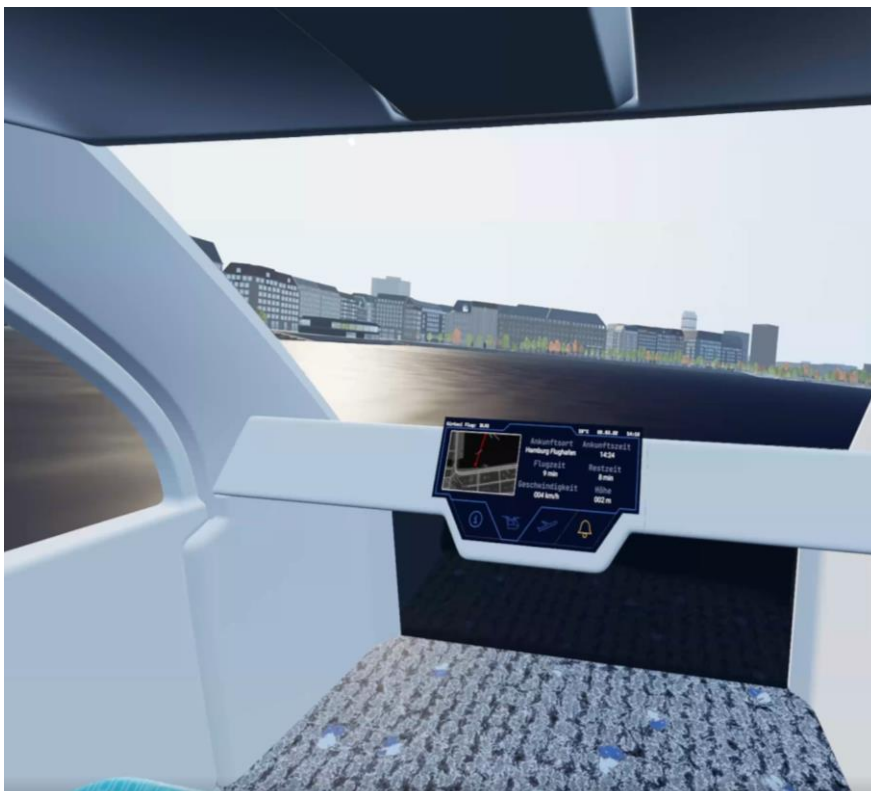


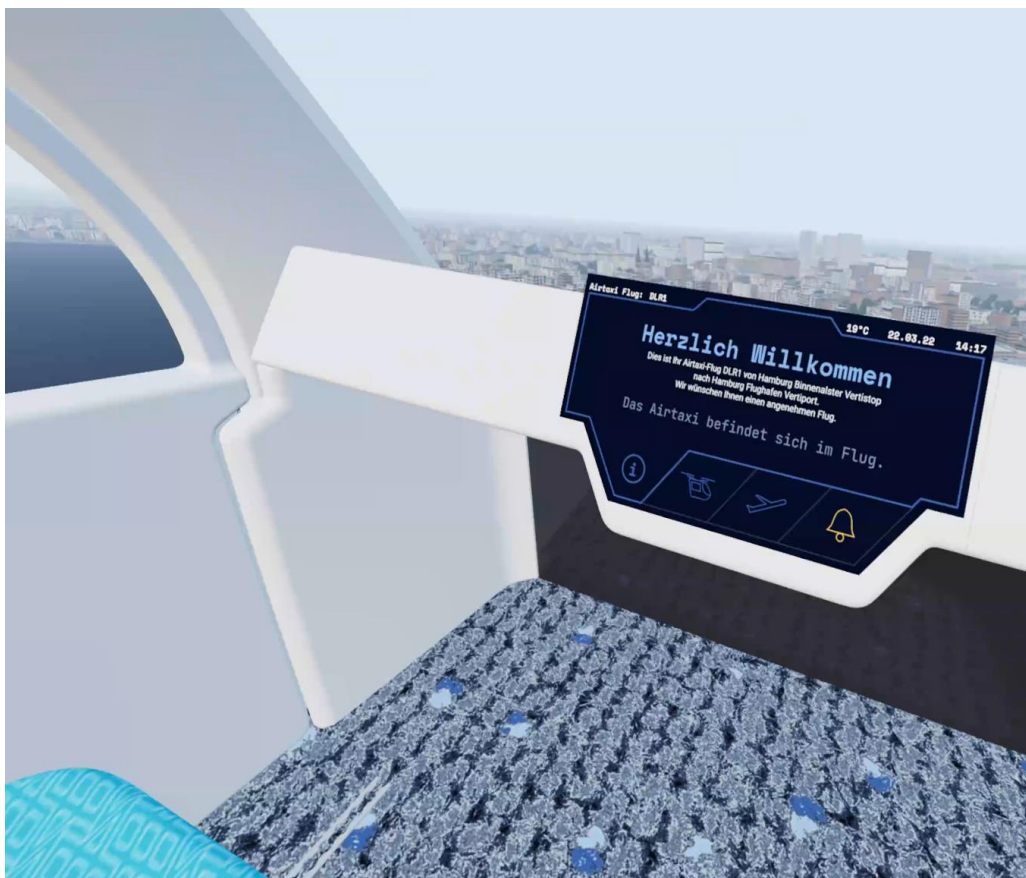
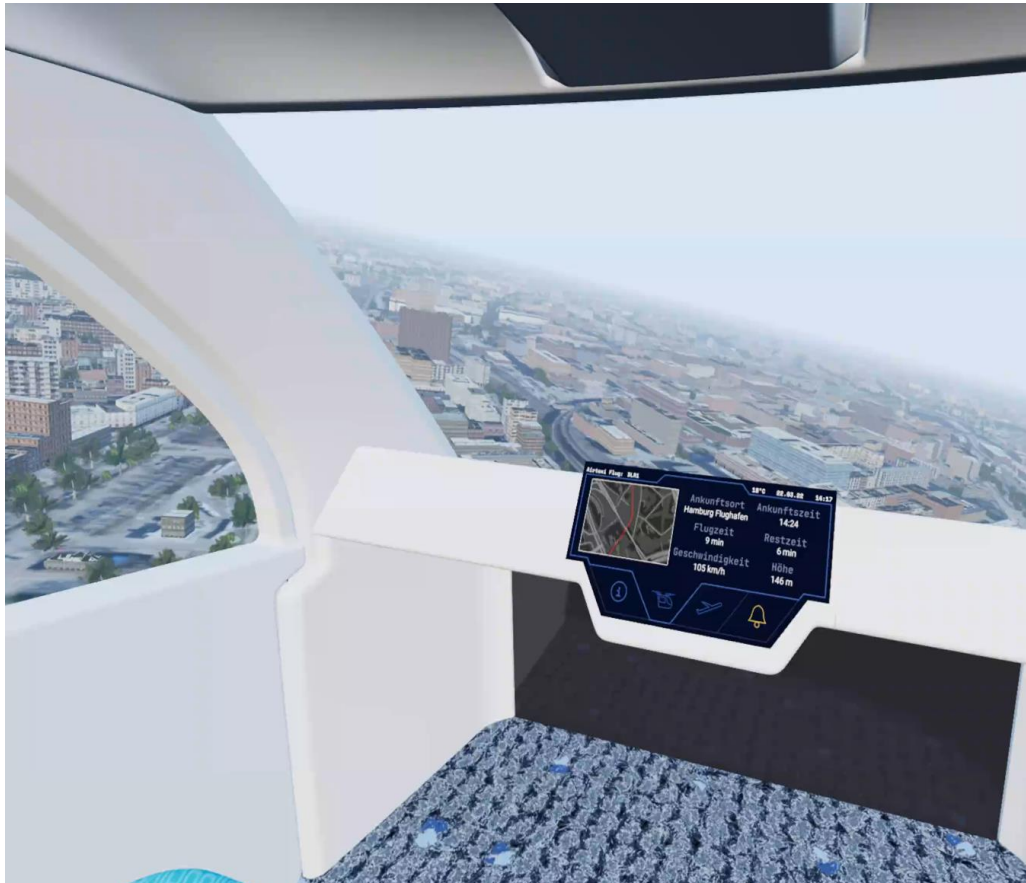


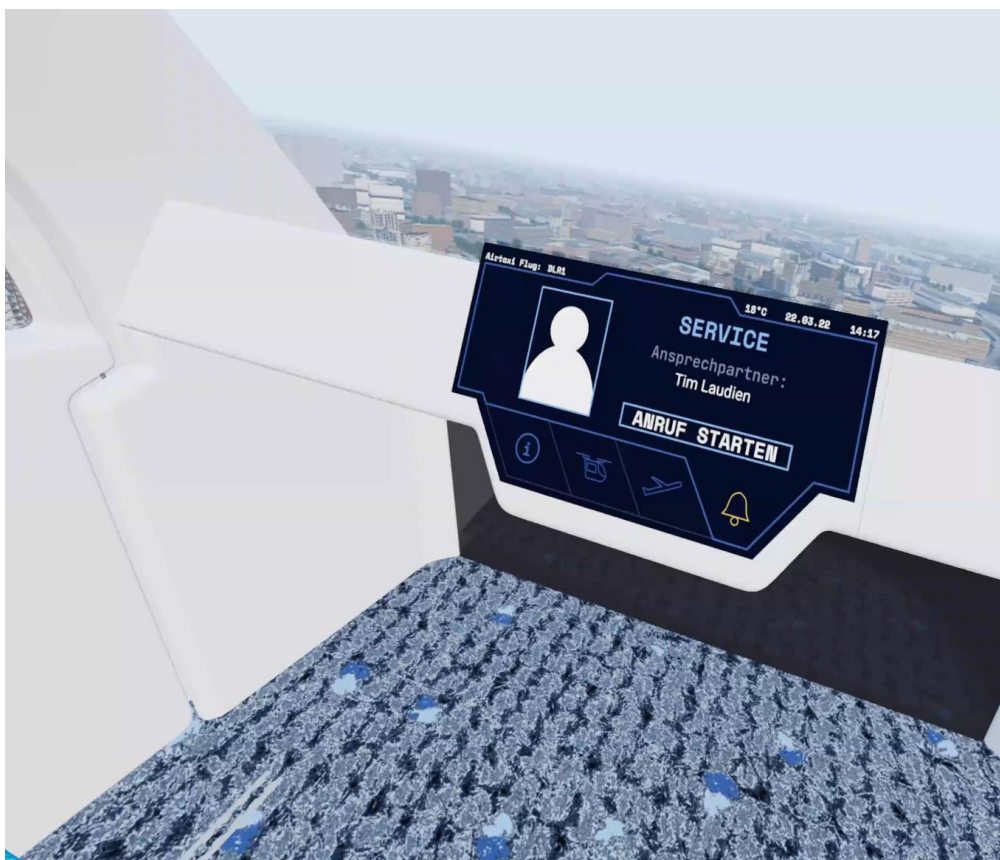
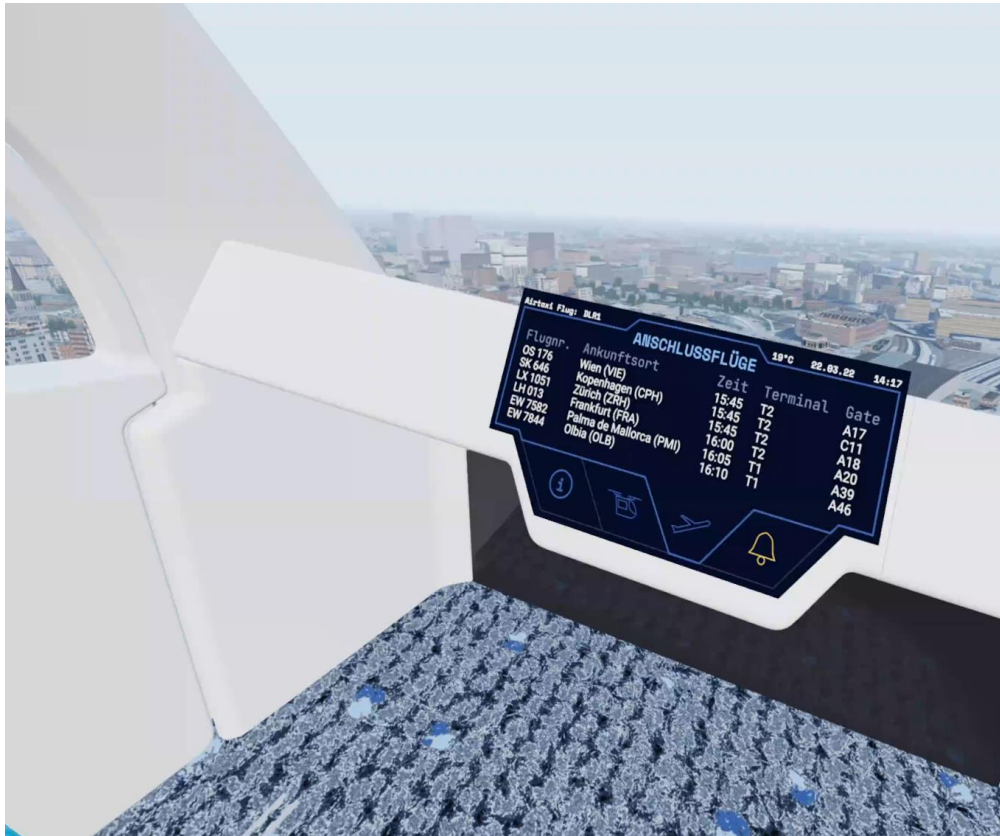


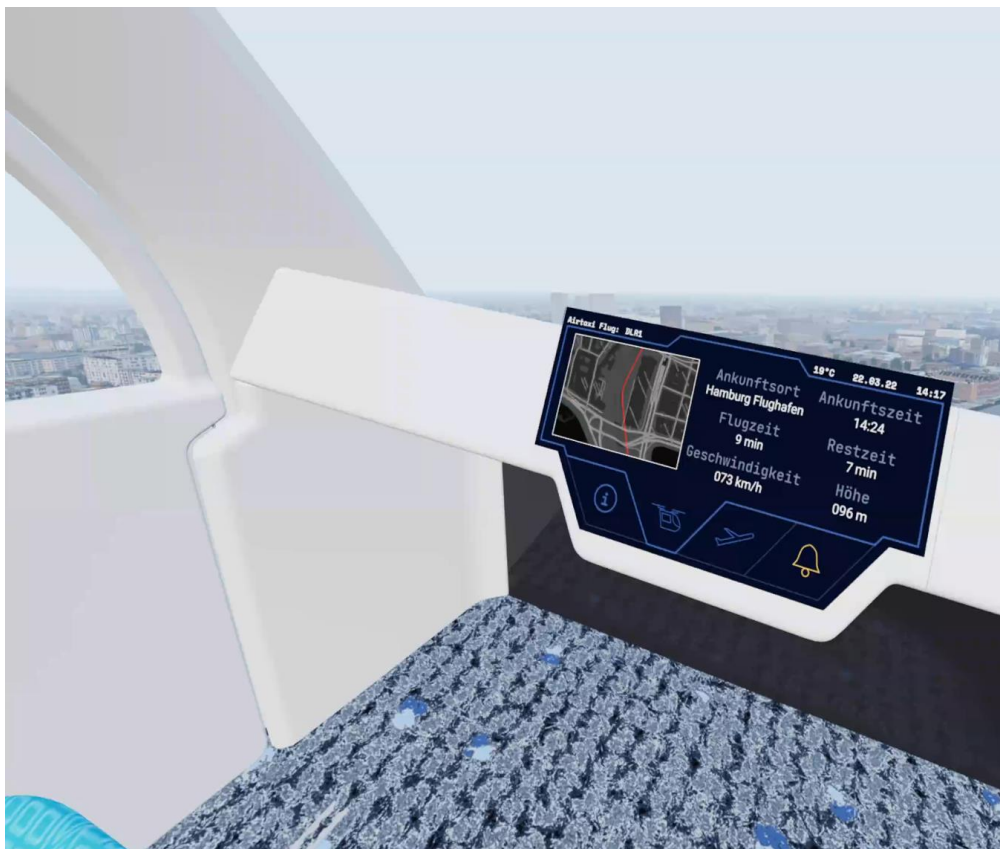
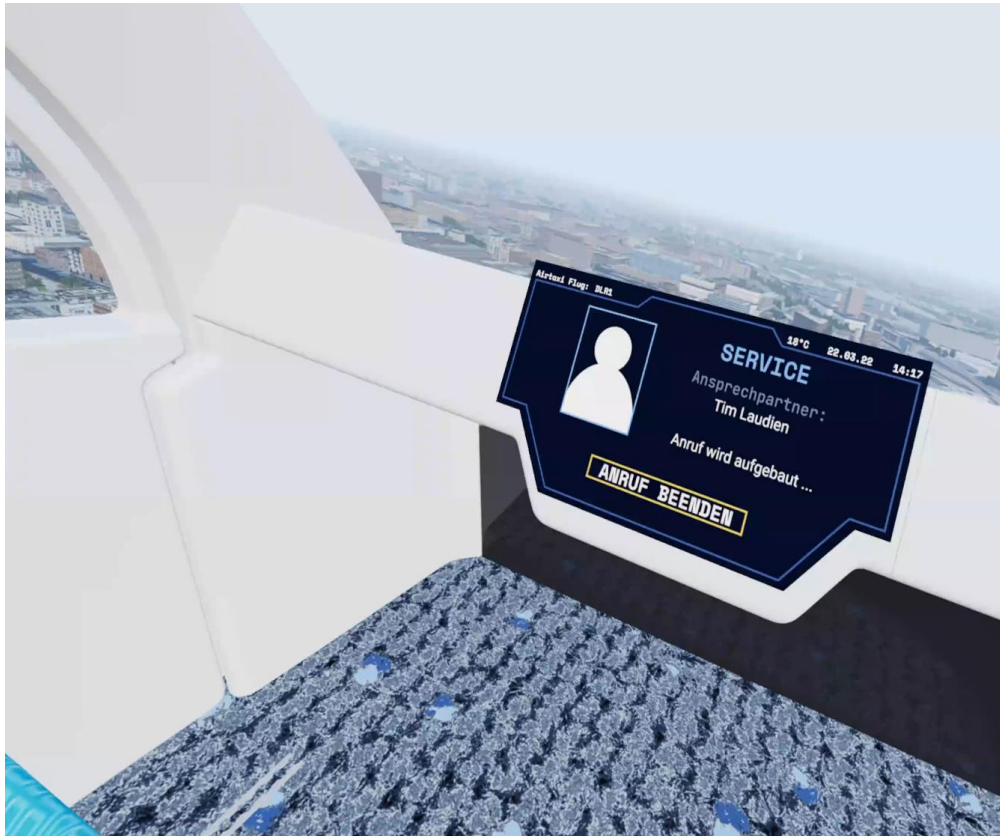
2. SETUP 4

The following screenshots should give an impression of a flight in the simulator during test setup 4 in scenario 2, which is described in chapter 10.









ANNEX F: TEST RESULTS QUESTIONNAIRE

PROBAND 1 (M/48)

FRAGEBOGEN:

1. Sind Probleme aufgetreten, während Sie das Display benutzt haben?

- Nein
- Es schien als schwebte das Display ca. 3cm über der Konsole in der Luft.

2. Waren Sie in der Lage alle Display-Elemente vernünftig zu lesen?

- Ja

3. Beschreiben Sie Ihren ersten Eindruck von dem Design.

- In Ordnung
- Es ist gut, dass es auf das Display angepasst ist
- Auf dem realen Tablet ist zu viel ungenutzter weißer Raum, da machen die abgerundeten Ecken keinen Sinn

4. Nennen Sie 3 bis 5 Adjektive, die Sie mit dem Design verbinden.

- Schlicht
- Funktional
- Technisch
- Gut

5. An welche Icons können Sie sich erinnern? Schreiben Sie ihre Bedeutung auf.

- Keine Erinnerung an das erste Icon = Begrüßung
- Helikopter = Allgemeine Infos über den Flug
- Abhebendes Flugzeug = Flugplan
- keine Erinnerung an die Glocke.
- Keine Mehrdeutigkeit.

6. Passt das Design des Displays zu dem Design der restlichen Kabine?

- Ja

7. Haben Ihrer Meinung nach Informationen gefehlt?

- Nein
- Karte vom Flughafen: Wo ist der Vertiport, wo geht's zu meinem Anschlussflug?

8. Welche Information ist für Sie die wichtigste, um sich im Flugtaxi sicher zu fühlen?

- Das es am Boden ist
- Akkustand bei elektrischem Fahrzeug
- Wetterinformationen

9. Geben Sie dem Display eine Schulnote:

- 2+

BEMERKUNGEN WÄHREND DER FLÜGE:

FLUG 1:

- Anrufen war kein Problem
- Viel Getippe am Anfang, erst danach passives herumschauen
- Display hat nicht immer sofort alle eingaben genommen

FLUG 2:

FLUG 3:

- Kein Problem mit dem ablesen der Startzeit des Anschlussfluges, hat es uns aber erst nach Aufforderung mitgeteilt
- Kein Problem das Datum laut vorzulesen (machte später eine Bemerkung sich doch verlesen zu haben)

FLUG 4:

- Keine Verzögerung die eigene Ankunftszeit laut vorzulesen, auch wieder erst nach Aufforderung

WEITERE BEMERKUNGEN:

- Die Höhe und Geschwindigkeit sollten nicht mit 3 Nullen vorne dran dargestellt werden
- Air taxi Geräusche sind zu laut, man hat sich gegenseitig nicht verstanden
- Tippt immer als erstes die Glocke an

PROBAND 2 (M/23)

FRAGEBOGEN:

1. Sind Probleme aufgetreten, während Sie das Display benutzt haben?

- Ja
- Ab und zu wurde die Eingabe auf den Tabs nicht erkannt

2. Waren Sie in der Lage alle Display-Elemente vernünftig zu lesen?

- Ja

3. Beschreiben Sie Ihren ersten Eindruck von dem Design.

- Übersichtlich
- Hat die Informationen angezeigt die man braucht
- Übersichtlich
- Einfach
- Selbsterklärend

4. Nennen Sie 3 bis 5 Adjektive, die Sie mit dem Design verbinden.

- Futuristisch
- Übersichtlich
- Dezent
- Stimmig

5. An welche Icons können Sie sich erinnern? Schreiben Sie ihre Bedeutung auf.

- Glocke = Anruf
- Flugzeug
- Info i = Herzlich Willkommen
- 4 Icons aber keine Erinnerung an die Icons für den eigenen Flug und die Abflüge

6. Passt das Design des Displays zu dem Design der restlichen Kabine?

- Ja

7. Haben Ihrer Meinung nach Informationen gefehlt?

- Nein

8. Welche Information ist für Sie die wichtigste, um sich im Flugtaxi sicher zu fühlen?

- Ansprechpartner

9. Geben Sie dem Display eine Schulnote:

- 1

BEMERKUNGEN WÄHREND DER FLÜGE:

FLUG 1:

- Schaut sich mehr um als mit dem Display zu interagieren
- Interagiert erst auf Aufforderung; Findet alles sehr gut
- Das Display reagiert teilweise nicht auf eingaben
- Findet die Anschlussstabelle super

FLUG 2:

- Abflugzeiten der Anschlussflüge passen nicht zu der eigentlichen Uhrzeit

FLUG 3:

- Virtuelles Display ist größer und schärfer
- Bedingung sehr gut
- Keine Verzögerung beim finden der Ankunftszeit

FLUG 4:

- Datum nach P2 Nachfrage gefunden und vorgelesen
- Display sieht wieder besser aus
- Interaktion funktioniert
- Voll virtuelles Setup hat sich besser angefühlt

WEITERE BEMERKUNGEN:

- Sieht das virtuelle Display schärfer als das Display auf dem Tablet

PROBAND 3 (M/28)

FRAGEBOGEN:

1. Sind Probleme aufgetreten, während Sie das Display benutzt haben?

- Nein

2. Waren Sie in der Lage alle Display-Elemente vernünftig zu lesen?

- Ja

3. Beschreiben Sie Ihren ersten Eindruck von dem Design.

- Nötigsten Infos
- Einleuchtende Icons
- Nicht zu beladen
- Gut

4. Nennen Sie 3 bis 5 Adjektive, die Sie mit dem Design verbinden.

- Intuitiv
- Nicht überladen
- Gut lesbar
- Strukturiert

5. An welche Icons können Sie sich erinnern? Schreiben Sie ihre Bedeutung auf.

- i = Karte und Ankunftszeit
- Departure = Departures für die nächsten Flüge
- Gelbe Glocke = Anruf
- viertes Symbol = Start Menu

6. Passt das Design des Displays zu dem Design der restlichen Kabine?

- Ja

7. Haben Ihrer Meinung nach Informationen gefehlt?

- Nein
- Die Abflugzeiten sind unnötig wenn man nicht zum Flughafen fliegt

8. Welche Information ist für Sie die wichtigste, um sich im Flugtaxi sicher zu fühlen?

- Position
- Geschwindigkeit
- Höhe

9. Geben Sie dem Display eine Schulnote:

- 2

BEMERKUNGEN WÄHREND DER FLÜGE:

FLUG 1:

- Schaut sich um
- Schaut raus
- Interagiert mit dem Display gar nicht
- Fragt erst nach bevor er mit dem Display interagiert
- Kann ohne Probleme einen Service Call absetzen
- Versucht mit der Karte zu interagieren
- Schaut sich weiter hauptsächlich um, interagiert sehr wenig mit dem Display

FLUG 2:

- Tippt gleich sofort auf dem Display herum
- Schaut sich dann aber weiter nur um
- Schaut sich die Hände an
- Versucht die Stühle anzufassen
- Kein Problem die Anschlussflugzeit zu finden und vorzulesen
- Schaut sich viele um, interagiert sehr wenig mit dem Display

FLUG 3:

- Schaut sich um, ganz einfach
- Schaut das Display sehr lange an, macht aber nichts
- Schaut einfach nur raus; Kein Problem damit das Datum vorzulesen
- Tippt sich einmal kurz durch alle Tabs aber mehr nicht
- Schaut sich noch nicht mal wirklich um sondern einfach nur nach vorn, bewegt sich kaum

FLUG 4:

- Tippt sich einmal durch alle Tabs und schaut dann weiter raus
- Schaut weiter raus nach vorn, sieht sich kaum noch um
- Tippt ein bisschen auf dem Display herum
- Findet seine Hände vor dem Fenster merkwürdig
- Muss kurz suchen, findet dann aber seine eigene Ankunftszeit
- Ihm fällt jetzt erst die Lücke im Fußraum auf
- Schaut sich noch ein bisschen seine Hände an der sonst passiv

PROBAND 4 (W/29)

FRAGEBOGEN:

1. Sind Probleme aufgetreten, während Sie das Display benutzt haben?

- Ja
- Die Tabs haben sich Zeitverzögert geändert
- Auf dem Tablet ist es schlecht leserlich

2. Waren Sie in der Lage alle Display-Elemente vernünftig zu lesen?

- Ja
- Abhängig vom Versuch: Schlechter mit Realen Display, gut mit komplett Virtuellen Display

3. Beschreiben Sie Ihren ersten Eindruck von dem Design.

- Erinnert an den Flughafen
- Das Blau aber auch die generelle Farbgebung war gut
- Die Kontraste zwischen den Farben waren gut, nicht zu extrem

4. Nennen Sie 3 bis 5 Adjektive, die Sie mit dem Design verbinden.

- Klar
- Eindeutig
- Bedeckte Farben
- Intuitiv
- Modern

5. An welche Icons können Sie sich erinnern? Schreiben Sie ihre Bedeutung auf.

- gelbes i = Info
- Flugtaxi Icon = Infos über das Flugtaxi
- Es gibt Anschlussfüge aber keine Erinnerung an das Icon
- gelber Telefonhörer = Anruf starten

6. Passt das Design des Displays zu dem Design der restlichen Kabine?

- Ja

7. Haben Ihrer Meinung nach Informationen gefehlt?

- Ja
- Icon auf der Karte das anzeigt wo man sich genau befindet
- Informationen wo man am Flughafen ankommt und wie man dann weiterkommt
- Der Anruf ist nicht eindeutig: ist es richtiger Service oder nur für Notfälle?

8. Welche Information ist für Sie die wichtigste, um sich im Flugtaxi sicher zu fühlen?

- Informationen über meinem Flug
- Wo bin ich und wie bewegt sich das Taxi?

9. Geben Sie dem Display eine Schulnote:

- 2

BEMERKUNGEN WÄHREND DER FLÜGE:

FLUG 1:

- Interagiert erst, wenn man es ihr auch sagt
- Kein Problem den Service Kopf zu finden und einen Anruf zu starten
- Hat nicht sofort erkannt, wo man sehen kann wie lange der Flug noch dauert
- Hätte gerne Informationen über die Umgebung

FLUG 2:

- Mag das Display und die Farben
- Die Schriftart erinnert sie an den Flughafen
- Kann sich auf der Karte nicht lokalisieren
- Hat Probleme, die Display Tabs zu wechseln
- Karte ist mehr wert wenn man genau sieht wo man ist
- Hat kein Problem die Anschlussflugzeit zu finden
- Hätte gerne die Informationen wo sie auf dem Flughafen ankommt und wie sie sich weiter bewegen muss

FLUG 3:

- Auf dem Tablet ist das Display viel kleiner
- Der weiße Rand stört
- Die Schrift ist verschwommen
- Das Display ist jetzt zu weit weg
- Datum ist zu klein und unscharf
- Als Rechtshänderin fühlt es sich unnatürlich an, immer rüber greifen zu müssen

FLUG 4:

- Display ist wieder zu klein, Weißer Rand stört
- Schrift ist undeutlich zu lesen
- Die Reaktion des Tablets ist gut
- Kein Problem die Ankunftszeit auf Nachfrage zu finden und vorzulesen
- Weißer Text auf Herzlich Willkommen Seite ist schwer zu lesen

WEITERE BEMERKUNGEN:

- Displayänderung wenn jemand den Servicruf entgegen nimmt
- Position der Tabs war gut
- Icons waren gut
- Die farbliche Hervorhebung war gut

PROBAND 5 (M/24)

FRAGEBOGEN:

1. Sind Probleme aufgetreten, während Sie das Display benutzt haben?

- Nein

2. Waren Sie in der Lage alle Display-Elemente vernünftig zu lesen?

- Ja

3. Beschreiben Sie Ihren ersten Eindruck von dem Design.

- Gut
- Angenehm zu lesen
- Intuitiv
- Interessante Form

4. Nennen Sie 3 bis 5 Adjektive, die Sie mit dem Design verbinden.

- Strukturiert
- Intuitiv
- Angenehm
- nicht ermüdend

5. An welche Icons können Sie sich erinnern? Schreiben Sie ihre Bedeutung auf.

- Flugzeug = Flugplan
- Klingel (Wie beim Fahrstuhl) = Serviceanruf
- Helikopter = Karte + Flugdaten
- i = Startseite, ist sich hier nicht mehr sicher, weil nach einmal lesen uninteressant

6. Passt das Design des Displays zu dem Design der restlichen Kabine?

- Ja

7. Haben Ihrer Meinung nach Informationen gefehlt?

- Nein

8. Welche Information ist für Sie die wichtigste, um sich im Flugtaxi sicher zu fühlen?

- Statuslampe: Etwas, was anzeigt, dass alles in Ordnung ist
- Für Leute, die Geräusche nicht einordnen können
- Falls das Taxi mal eine Kurve zu scharf nimmt

9. Geben Sie dem Display eine Schulnote:

- 1

BEMERKUNGEN WÄHREND DER FLÜGE:

FLUG 1:

- Schaut rum, interagiert nicht mit dem Display
- Auch nach Aufforderung wird nicht mit dem Display interagiert
- Hat nach dem Datum erst kurz suchen müssen
- Immer noch keine Interaktion mit dem Display
- Auch nach zweiter Aufforderung keine Interaktion, schaut lieber weiter rum
- Absolut kein Interesse am Display

FLUG 2:

- Hat das Display berührt aber keine Interaktion ausgelöst
- Dritte Aufforderung: Bedient endlich das Display, Nachfrage des Probanden ob es schon die ganze Zeit ging
- Keine Probleme um einen Service Call zu machen
- Schaut weiterhin lieber nach draußen
- Sparsame Interaktion (wegen schlechten Handtracking??)

FLUG 3:

- Kein Problem die Ankunftszeit vorzulesen
- Display hat erst nicht funktioniert
- Interagiert immer noch zaghaft mit dem Display
- Schaut sich lieber weiter um

FLUG 4:

- Display reagiert sehr schlecht
- Nach Nachfrage des Probanden die Anschlussflugzeit richtig vorgelesen

WEITERE BEMERKUNGEN:

- "Wenn ich da morgens um 6 Uhr einsteige, wird es mich nicht erschlagen."
- Display zu bedienen ist einfacher wie bei den Display static tests zuvor

PROBAND 6 (M/47)

FRAGEBOGEN:

1. Sind Probleme aufgetreten, während Sie das Display benutzt haben?

- Nein
- Die Tabs haben nicht sofort reagiert, wenn man sie berührt hat

2. Waren Sie in der Lage alle Display-Elemente vernünftig zu lesen?

- Ja

3. Beschreiben Sie Ihren ersten Eindruck von dem Design.

- Ansprechend
- Selbsterklärend
- Wäre gut zu wissen wo man am Flughafen ankommt
- Eine Anzeige die einem zeigt wie lange man zum Gate braucht und "Umsteigzeit"

4. Nennen Sie 3 bis 5 Adjektive, die Sie mit dem Design verbinden.

- Aufgeräumt
- Nicht Komplex
- Gut leserlich

5. An welche Icons können Sie sich erinnern? Schreiben Sie ihre Bedeutung auf.

- Info = Infoscreen
- Flugtaxi = Flug- Rest- und Ankunftszeit
- Startendes Flugzeug = Anschlussflüge
- Glocke = Telefon
- Die Buttons waren selbsterklärend nach dem ersten durchklicken
- ein Telefonhörer wäre vielleicht besser als die Glocke, bei Glocke erwartet man die Stewardess

6. Passt das Design des Displays zu dem Design der restlichen Kabine?

- Ja

7. Haben Ihrer Meinung nach Informationen gefehlt?

- Ja
- Entertainment
- Karte vom Flughafen wäre gut: Wo ist eine Toilette, Wo gibt es was zu Essen, Wie lang ist die Schlange an der Security
- Einen Knopf um Labels an den Sehenswürdigkeiten anzuzeigen an denen man vorbei fliegt

8. Welche Information ist für Sie die wichtigste, um sich im Flugtaxi sicher zu fühlen?

- Das Display muss auf jeden Fall funktionieren
- Eine Lampe die den Flugstatus anzeigt (grün = gut)
- Höhe und Geschwindigkeit

9. Geben Sie dem Display eine Schulnote:

- 2

BEMERKUNGEN WÄHREND DER FLÜGE:

FLUG 1:

- Schaut sich um, interagiert noch gar nicht mit dem Display
- Hat erst nach Aufforderung mit dem Display interagiert
- Hat das zweite Icon sofort richtig als Air taxi erkannt
- Konnte mir auch erst nicht sagen wann er ankommt, da er nicht mit dem Display interagiert hat
- Das Display hat nicht funktioniert
- hat mehrmals versucht die Karte zu verschieben

FLUG 2:

- Schaut weiterhin lieber nach draußen
- Würde selber nicht in einem Flugtaxi fliegen
- Konnte das Datum ohne Probleme finden und vorlesen
- Würde gerne wissen wo er am Airport ankommt
- Hat die Terminals ohne Probleme selber laut vorgelesen
- Würde gerne wissen wie lange die U- oder S-Bahn braucht für dieselbe Strecke

FLUG 3:

- Keine Probleme den Anruf zu finden und abzusetzen
- War der erste Proband der es nicht selbstständig gemacht hat
- Wundert sich über das Placeholder Foto, hätte lieber das Bild eines richtigen Operators
- Labels über Sehenswürdigkeiten durch einen Knopf aktivieren und den Flugpfad anzeigen, als Hologramm auf die Scheiben

FLUG 4:

- Hätte gerne eine reale Videoaußensicht
- Touch-Eingaben bei dem Display schwierig
- Hätte lieber echte Knöpfe für echtes Feedback, sodass man rausgucken kann und trotzdem weiß, dass man einen Knopf gedrückt hat

PROBAND 7 (W/28)

FRAGEBOGEN:

1. Sind Probleme aufgetreten, während Sie das Display benutzt haben?

- Nein

2. Waren Sie in der Lage alle Display-Elemente vernünftig zu lesen?

- Ja
- Guter Kontrast
- Bei dem komplett virtuellen Display gab es gar keine Leseschwierigkeiten
- Bei der Darstellung auf dem Tablet schon, vor allem der Text auf der ersten Seite

3. Beschreiben Sie Ihren ersten Eindruck von dem Design.

- Cool
- Sehr gut
- Die vier Reiter unten sind ausreichend, alles andere wäre zu viel Info
- Nicht überladen
- Der Anruf macht einen sicher aber ein Foto eines echten Menschen wäre gut für die persönliche Bindung und Sicherheitsgefühl

4. Nennen Sie 3 bis 5 Adjektive, die Sie mit dem Design verbinden.

- Futuristisch
- Übersichtlich
- Intuitiv
- Gut leserlich
- Genauso wie man es sich vorstellt
- unterhaltsam (es hat abgelenkt)

5. An welche Icons können Sie sich erinnern? Schreiben Sie ihre Bedeutung auf.

- 4 Icons
- ? = Bild + Anruf
- Air taxi = Flughöhe, Geschwindigkeit, Map, Temperatur, Flugnummer
- Abhebendes Flugzeug = Verbindungsflüge
- Ein Icon + Inhalt fehlt

6. Passt das Design des Displays zu dem Design der restlichen Kabine?

- Ja
- Es passt zum DLR und zur Kabine
- der Kontrast ist super
- Passt zum Ingenieur
- Die Stühle sind zu traditionell
- Der Teppich ist grausam

7. Haben Ihrer Meinung nach Informationen gefehlt?

- Nein

8. Welche Information ist für Sie die wichtigste, um sich im Flugtaxi sicher zu fühlen?

- Die Anruffunktion
- Die Gurte

9. Geben Sie dem Display eine Schulnote:

- 2

BEMERKUNGEN WÄHREND DER FLÜGE:

FLUG 1:

- "Das Display hat TU Braunschweig vibes"
- Hat sehr lange das Display angestarrt aber nicht damit interagiert
- War nach erster Aufforderung zu abgelenkt um etwas zu machen
- Sitzt sehr angespannt da
- Hatte Probleme mit der Brille und war deswegen abgelenkt
- Hat sich das Display nur angeschaut aber nichts damit gemacht

FLUG 2:

- Der Text der anzeigt, ob man steht oder fliegt ist super
- Kann ohne Probleme die Temperatur lesen
- "Das ist aber cool" als die Seite mit den Flugtaxi Informationen zum ersten Mal aufgerufen wurde
- Anschlussflugtabelle ist auch ziemlich cool
- Hätte gerne ein Bild des Ansprechpartners
- Findet das Display lenkt zu sehr vom eigentlichen Flug ab
- Hat erst beim zweiten mal den Operator angerufen
- Kann die Städtenamen ohne Probleme vorlesen

FLUG 3:

- Schaut sich lieber weiter um
- Kein Problem die Ankunftszeit vorzu lesen

FLUG 4:

- Trifft immer genau das Icon auf dem Tab und dadurch wechseln die Bildschirme nicht
- Hat dieses Mal wieder ein bisschen mehr auf dem Display herum gedrückt

WEITERE ANMERKUNGEN:

- Es wird ganz schön stickig in der Kabine

PROBAND 8 (M/26)

FRAGEBOGEN:

1. Sind Probleme aufgetreten, während Sie das Display benutzt haben?

- Ja
- Das virtuelle Display hat nicht immer reagiert
- Es gab zu große Abweichungen zu dem realen, haptischen Feedback
- Die Karte hat nicht funktioniert

2. Waren Sie in der Lage alle Display-Elemente vernünftig zu lesen?

- Ja

3. Beschreiben Sie Ihren ersten Eindruck von dem Design.

- Überzeugendes Design
- Auf der ersten Seite könnte während des Fluges mehr passieren
- Ob man im Flug ist oder am Boden ist eine gute Anzeige
- Intuitiv
- Die Farben passen zu aktuellen Designstandards

4. Nennen Sie 3 bis 5 Adjektive, die Sie mit dem Design verbinden.

- Modern
- Intuitiv
- Informativ
- strukturiert

5. An welche Icons können Sie sich erinnern? Schreiben Sie ihre Bedeutung auf.

- i = Service (man interagiert nicht so oft mit dem Service vielleicht wüsste man es dann besser wenn man eine Aufgabe dazu hat)
- Flugtaxi Icon = Infos über das Flugtaxi
- Steigendes Flugzeug = Anschlussfüge
- Keine Erinnerung an das Icon für die erste Informationsseite

6. Passt das Design des Displays zu dem Design der restlichen Kabine?

- Ja

7. Haben Ihrer Meinung nach Informationen gefehlt?

- Nein

8. Welche Information ist für Sie die wichtigste, um sich im Flugtaxi sicher zu fühlen?

- Zuverlässigkeit, das ist allerdings keine Information die man so darstellen könnte
- Es gibt keine konkrete Information die helfen könnte da das Misstrauen aus vielen verschiedenen Bereichen kommt

9. Geben Sie dem Display eine Schulnote:

- 1

BEMERKUNGEN WÄHREND DER FLÜGE:

FLUG 1:

- Macht es sich bequem, schaut sich um
- Klickt schonmal auf dem Display herum
- Hat einmal alle Tabs durchgeklickt
- Musste kurz suchen konnte aber ohne Probleme den Anschlussflug finden
- Hat keine Probleme anzurufen
- "Das N in Anschlussflüge sieht komisch aus, es passt überhaupt nicht zum Rest der Schriftart"
- "Interessante Anruffunktion"
- Hätte gerne Soundfeedback, dass der Anruf aufgebaut wird

FLUG 2:

- Tippt eifrig auf dem Display herum
- Warum reagiert die Map auf Eingaben wenn man damit nichts machen kann, sie sollte statisch sein wie ein Videobild
- Keine Probleme das Datum vorzulesen
- Schaut sich viel im Taxi um

FLUG 3:

- Erstmal ausprobieren was die virtuellen Hände wirklich können und wo die Tracker Probleme bekommen
- Interagiert mit dem Display, schaut sich dann aber lieber weiter um
- Wünscht sich mehr aktive Finger
- Keine Sonne für die Schatten
- Die angezeigte Fläche ist größer als das reale Display bzw. die haptische Feedbackfläche

FLUG 4:

- Kein Fan davon, dass man die Hände über den virtuellen Fenstern nicht sehen kann
- Interagiert wieder mit der Karte
- Schaut lieber raus und sucht nach Fehlern in der Darstellung
- Kein Problem damit, die Ankunftszeit vorzulesen
- Testet lieber die virtuelle Darstellung und die Brille auf ihre Belastbarkeit
- Türspalten sind zu groß, man kann dadurch die reale Außenwelt sehen

PROBAND 9 (M/48)

FRAGEBOGEN:

1. Sind Probleme aufgetreten, während Sie das Display benutzt haben?

- Nein

2. Waren Sie in der Lage alle Display-Elemente vernünftig zu lesen?

- Ja

3. Beschreiben Sie Ihren ersten Eindruck von dem Design.

- Klar strukturiert, auch die Infos
- Keine Infos die gefehlt haben
- "So würde ich mir das Vorstellen"
- Keine Wünsche
- Gestaltung und Bedienbarkeit gut

4. Nennen Sie 3 bis 5 Adjektive, die Sie mit dem Design verbinden.

- Ansprechend
- Praktisch
- Effizient

5. An welche Icons können Sie sich erinnern? Schreiben Sie ihre Bedeutung auf.

- Abhebendes Flugzeug = Departures
- i = info page eins
- Telefon für die letzte Seite = Anrufen
- Keine Erinnerung an das Flugtaxi oder einen Kommentar zu der Seite

6. Passt das Design des Displays zu dem Design der restlichen Kabine?

- Ja

7. Haben Ihrer Meinung nach Informationen gefehlt?

- Nein

8. Welche Information ist für Sie die wichtigste, um sich im Flugtaxi sicher zu fühlen?

- Sicherheitsgefühl kann nicht durch Informationen auf dem Display entstehen
- Ablauf wäre gut zu wissen
- Die Position auf der Karte anzeigen wäre gut, Wo bin ich und wie weit ist das Ziel noch weg?

9. Geben Sie dem Display eine Schulnote:

- 2

BEMERKUNGEN WÄHREND DER FLÜGE:

FLUG 1:

- Schaut sich um
- Keine Interaktion
- Bewertet lieber den Flug außerhalb
- Kein Interesse an dem Display
- Diskutiert lieber technische Details und den Hintergrund
- Erkennt die Flugroute wieder
- Würde mit einem Flugtaxi fliegen
- Hat um Erlaubnis gefragt bevor er mit dem Display interagiert hat
- Kein Problem die Tabelle vorzulesen, wusste aber nicht wofür die Info gut ist
- Der Text könnte kleiner sein, der weiße Text auf der ersten Seite ist perfekt
- Hat ohne Probleme einen Serviceanruf abgesetzt und einen Drink bestellt

FLUG 2:

- Die virtuelle Hand passt nicht ganz zu der realen Hand
- Schaut sich lieber weiter um
- Klickt sich einmal durch alle Tabs
- Obwohl man kein physisches Feedback bekommt, fühlt es sich am Ende real an
- Nicht besonders viel interagiert, lieber weiter rausgeschaut

FLUG 3:

- Tippt am Anfang auf dem Display herum aber eher nur um zu schauen ob es auch wirklich funktioniert
- Hat viele Fragen zum Versuchsaufbau und der Durchführung
- Ist sehr von dem Konzept überzeugt
- Schaut sich um
- Fragt sich warum wir über eine S-Bahnstrecke fliegen

FLUG 4:

- Drückt sich wieder einmal durch die Tabs um zu gucken ob sie funktionieren
- Schaut weiterhin lieber raus und sich um
- Kann das Datum ohne Probleme lesen

WEITERE ANMERKUNGEN:

- Helles Display würde nur blenden im dunklen Kabinenkontext, draußen ist immer hell

PROBAND 10 (M/39)

FRAGEBOGEN:

1. Sind Probleme aufgetreten, während Sie das Display benutzt haben?

- Ja
- Die Buttons haben nicht reagiert
- Welche Hand ist der Referenzpunkt
- Hat auch versucht, in der Gegend des Buttons herum zu drücken aber es hat nichts geholfen

2. Waren Sie in der Lage alle Display-Elemente vernünftig zu lesen?

- Ja
- Komplette virtuelles Display ist einfacher zu lesen als das auf dem Tablet aber es macht keinen großen Unterschied

3. Beschreiben Sie Ihren ersten Eindruck von dem Design.

- Modern
- Simpel
- Gut lesbar durch den Kontrast
- Die Buttons waren groß genug
- gut gefallen

4. Nennen Sie 3 bis 5 Adjektive, die Sie mit dem Design verbinden.

- Modern
- Simpel
- Minimalistisch
- Übersichtlich
- Einfach zu bedienen
- Intuitiv
- Schnell verständlich durch die Icons

5. An welche Icons können Sie sich erinnern? Schreiben Sie ihre Bedeutung auf.

- Flugzeug = An- und Abflug
- Gelbes Dreieck = Anruf
- Hubschrauber/taxi = Infos über den Status
- Begrüßungsinformation aber keine Erinnerung an das Icon

6. Passt das Design des Displays zu dem Design der restlichen Kabine?

- Nein
- Beides ist minimalistisch, vom Stil wurde etwas anderes erwartet
- Es sticht heraus da es modern ist und der Rest der virtuellen Einrichtung eher nach 80er Jahre Linienbus aussah
- Es wurde aber nicht als störend empfunden

7. Haben Ihrer Meinung nach Informationen gefehlt?

- Nein

- Informationen über die Umgebung wären cool

8. Welche Information ist für Sie die wichtigste, um sich im Flugtaxi sicher zu fühlen?

- Wie funktioniert so ein Flugtaxi?
- Sicherheitseinweisung (Wo sind die Fallschirme?)

9. Geben Sie dem Display eine Schulnote:

- 2

BEMERKUNGEN WÄHREND DER FLÜGE:

FLUG 1:

- schaut erst ganz lange das Display an bevor er umschaut
- Interagiert nicht mit dem Display
- Hätte gerne einen Joystick und Laserkanonen
- Schaut sich das das ganze Taxi an
- Auch die Rückbank
- Beginnt nach Aufforderung vorsichtig zu interagieren
- Hat ohne Probleme den Service angerufen und wollte eine Pizza bestellen und wissen wie teuer der Flug ist
- "Cool"
- Der Start ist sehr überzeugend, allerdings sollte ein Abhebe-Gefühl kommen
- Der Flug verliert Realität, da die Texturen nicht real genug sind;

FLUG 2:

- Tippt sofort drauf los
- Versucht mit der Karte zu interagieren
- Schaut weiter raus; Fast Dinge an
- Schaut wie seine Hände reagieren auch auf die virtuelle Welt
- Kann ohne Probleme das Datum lesen; Spielt weiter mit der karte herum

FLUG 3:

- Klickt wieder kurz durch alle Tabs
- Versucht wieder mit der Karte zu interagieren
- Schaut sich die Anschlussflugtabelle kurz an
- Versucht den "Luftschlitz" zu berühren
- Hätte gerne einen Beifahrer
- Hat erst suchen müssen, hat dann aber die Information über die Ankunftszeit gefunden und vorgelesen
- Findet die Masken für die realen Hände noch nicht perfekt aber gut

FLUG 4:

- Das Display funktioniert nicht
- "Die Karte ist Fudsch"
- Klickt sich durch alle Tabs und schaut sich dann lieber um
- "Das Display reagiert schlecht"
- Kann ohne Probleme den Anschlussflug nach Zürich finden und laut vorlesen

- Mehr Interaktion findet nicht statt

PROBAND 11 (W/36)

FRAGEBOGEN:

1. Sind Probleme aufgetreten, während Sie das Display benutzt haben?

- Ja
- Manchmal musste man zweimal tippen; Es hat besser funktioniert als in dem ersten Teil der Studie

2. Waren Sie in der Lage alle Display-Elemente vernünftig zu lesen?

- Ja

3. Beschreiben Sie Ihren ersten Eindruck von dem Design.

- Ansprechend
- Nicht aufdringlich
- Übersichtlich
- hat gut gefallen

4. Nennen Sie 3 bis 5 Adjektive, die Sie mit dem Design verbinden.

- Übersichtlich
- Intuitiv
- Übersichtlich
- Nichts außergewöhnliches

5. An welche Icons können Sie sich erinnern? Schreiben Sie ihre Bedeutung auf.

- 4 Icons
- i = erste Infos
- Lufttaxi = kein Kommentar
- Flugzeug = Anschlussflüge
- Glocke = Serviceanruf

6. Passt das Design des Displays zu dem Design der restlichen Kabine?

- Ja
- Schlicht wie das Taxi; Das größere Display ist attraktiver, macht mehr her

7. Haben Ihrer Meinung nach Informationen gefehlt?

- Nein

8. Welche Information ist für Sie die wichtigste, um sich im Flugtaxi sicher zu fühlen?

- Ankunftszeit
- Notruf

9. Geben Sie dem Display eine Schulnote:

- 1

BEMERKUNGEN WÄHREND DER FLÜGE:

FLUG 1:

- Liest die erste Seite
- Schaut sich um, durch das ganze Taxi
- Fragt nach bevor sie auf dem Display herum tippt
- Macht ohne Probleme einen Service Anruf
- Wundert sich, dass sie Hände hat aber keine Beine
- Tracking ist verschoben; Schaut sich mehr um als mit dem Display zu interagieren
- Taxi Interior sieht aus wie von einem öffentlichen Verkehrsmittel
- Kann die Anschlussflüge lesen und verstehen

FLUG 2:

- Schaut sich um, interagiert nicht mit dem Display
- Berührt das Taxi viel
- Klickt sich einmal durch das reale Display
- Die reale Kabine ist viel schmutziger
- hat keine Probleme damit das Datum vorzulesen, hat sich aber etwas nach vorne gebeugt
- Dieses Setup ist realer, das virtuelle ist zu sauber, zu weiß

FLUG 3:

- Schaut sich um, fasst alles an
- Drückt sich noch einmal durch das Display
- Fragt sich die ganze Zeit, was in diesem Setup anders ist als im Setup davor
- Der Flug ist abgestürzt
- Hat leichtes Bildrauschen über den realen dunkelten Flächen
- Einige der Häuser clippen übereinander

FLUG 4:

- Wenn das Display größer ist, sieht es schicker aus
- Das Display steht oben über der Kante
- Klickt ein bisschen auf dem Display herum
- Findet die zwei Hände übereinander "lustig"
- Muss kurz suchen, findet dann aber ohne Probleme die Ankunftszeit
- Findet es irritiert, dass die Kiste durch den virtuellen Stuhl clippt
- Fragt sich, wann die virtuellen Hände detektiert werden
- Findet es interessant
- Wie gut das Handtracking ohne Handschuhe funktioniert
- "Das ist schon cool, was das Setup alles kann"
- Serviceanrufantwort über Lautsprecher einspielen

PROBAND 12 (M/47)

FRAGEBOGEN:

1. Sind Probleme aufgetreten, während Sie das Display benutzt haben?

- Nein

2. Waren Sie in der Lage alle Display-Elemente vernünftig zu lesen?

- Ja
- Reales Display ist am schlechtesten zu lesen
- Das digitale Display wäre zu groß, da wäre Platz für mehr Informationen

3. Beschreiben Sie Ihren ersten Eindruck von dem Design.

- War stimmig
- Vielleicht Abgerundete Kanten
- Zufrieden; die Geometrien sind sehr schön
- Mehr Asymmetrie
- Tabs sind super aber zu lang
- Die Dinge die oben immer gleichbleiben sehen gut aus;

4. Nennen Sie 3 bis 5 Adjektive, die Sie mit dem Design verbinden.

- Star Trek
- Futuristisch
- Dezent wegen den wenigen Farben
- Kühl
- Informativ

5. An welche Icons können Sie sich erinnern? Schreiben Sie ihre Bedeutung auf.

- i = Info
- Air taxi = eigener Zustand
- Departure Symbol = Terminal
- Gelbe Glocke = Notfall Anruf

6. Passt das Design des Displays zu dem Design der restlichen Kabine?

- Ja
- Genauso wie man sich das vorstellt
- Dinge über die Form zusammenbringen
- Es fehlt ganz viel damit es sich real anfühlt
- Mehr Aufbau
- Lieber zwei Displays
- Infotainment
- Platzierung ist richtig
- Hinten braucht man auch Displays

7. Haben Ihrer Meinung nach Informationen gefehlt?

- Ja

- Tageszeitung oder Nachrichten
- Verspätung von Flügen
- Mehr Karte = mehr herauszoomen, die Häuser verlassen das Display zu schnell
- Symbol auf der Karte das zeigt, wo man ist
- Kartensicht wie im Flugzeug; Eine Karte soll mich auf die Zukunft vorbereiten

8. Welche Information ist für Sie die wichtigste, um sich im Flugtaxi sicher zu fühlen?

- Grüne Lampe die nicht ausgeht = alles ist gut, da man selber keinen Einfluss auf den Flug hat
- Man hat keinen Kontakt zum Boden - wenn es ausgeht fällt es runter
- Das, das System mir sagt, was ich tun kann oder mich beruhigt

9. Geben Sie dem Display eine Schulnote:

- 1
- Sehr gute Leistung

BEMERKUNGEN WÄHREND DER FLÜGE:

FLUG 1:

- Schaut sich um
- Stellt technische Fragen an den Versuchsaufbau
- Kein Interesse an dem Display
- Brauchte eine Erklärung, bevor er mit dem interagieren anfängt
- Fragt ob man wirklich anrufen kann, der Kollege sagt ja, der Proband tippt dann einfach auf ein anderes Feld um auf eine andere Seite zu kommen
- Guckt sich um, fragt nach anderen Aufgaben
- Guckt sich seine Hände vor dem Fenster an
- "Tolle Technik"
- Diskutiert viel über die Auslegung der Fragen

FLUG 2:

- Berührt als erstes das Display, löst aber keine Interaktion aus
- Probiert die virtuellen Hände aus
- Fasst das Dashboard genau vor ihm an
- Fragt nach den technischen Gründen hinter dem Nebel
- Höherer Kontrast bei der Karte, man bekommt sehr wenig Informationen
- Kann die Informationen von außen nicht mit den Informationen auf der Karte abgleichen
- Würde gerne aus der Karte zoomen - generell aus der Karte zoomen für mehr Infos
- Keine Probleme den Anschlussflug zu finden und vorzulesen

FLUG 3:

- Fasst als erstes das Dashboard an
- Kontrolliert seine virtuellen Finger
- Testet alle Finger durch würde gerne alle Finger der virtuellen Hand benutzen
- Schaut sich die Karte ganz genau an
- Hat ohne Probleme die Restzeit gefunden und vorgelesen
- Schaut sich weiterhin lieber um und interagiert sehr wenig mit dem Display

FLUG 4:

- Schaut sich weiterhin sehr viel um
- Schaut wie seine Hand vor den Fenstern ist
- Keine Probleme, das Datum vorzulesen
- Klickt sich nur einmal durch alle Tabs
- Testet lieber das Sichtfeld der Brille

WEITERE ANMERKUNGEN:

- Eine Drohne ist im Flug um einiges stabiler als der Helikopter
 - Lauter und Niedrigfrequenz Geräusche
 - Es ist wichtiger, dass er sich bewegt als das Geräusch
 - Es muss höher und braucht mehr Stauraum
-
- Man braucht mehr Geschichte und Getränkehalter
 - Man braucht den ganzen Aufbau und den Vertiport
 - Nachrichtenseite oder Tageszeitung
 - Spiele auf dem Display
 - Man braucht die Abflüge nicht, ich habe meine Flug ja schon gebucht
 - Wünscht sich mehr Interaktion mit dem ganzen Cockpit