



COMP1649

Human Computer Interaction and
Design

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I. Introduction

Today, interaction design plays a very important role in product development for users. To have a good product for the end user, I will have to apply the field of interaction design to my product. Here I will create a concept and a prototype of a car navigation and entertainment system. In which the prototype is designed with low fidelity and high fidelity to be able to see more clearly the product that we intend to design. Next, in this report, I will present some important concepts in interaction design, such as: five dimensions, cognitive psychology in interaction design, and how they apply to my product. Additionally, I will present an empirical study to test the assumptions made in the prototype design and plan their usability testing prior to product delivery.

II. Processes and framework for interaction design

1. The process of Interaction

According (Preece et al, 2015) the interaction design process consists of four basic activities:

- ❖ Establishing requirement: To design a product that supports everyone, the first thing we need to know is what the user wants. The identification of requirements and desires from users can be through observation, interview,...
- ❖ Designing alternatives: offer solutions tailored to user needs through conceptual models of products. It helps users visualize what users can interact with the product.
- ❖ Prototyping: provide the user with a stub to give the user a first look at the product
- ❖ Evaluating: refers to the process of determining the usability and acceptability of a product, as well as the user experience.

A good result requires a process, few people can make a good product the first time. Therefore, iterating the above processes to get the product that matches the user's requirements is necessary in the design process (Preece et al, 2015).

2. Frameworks

A framework is a collection of interconnected concepts and specific questions designed to offer data for a specific topic. They advise designers on what they should design. Below I will present 2 popular design frameworks which are: User-centered, Goal-oriented.

❖ User-centered

According (Abrams et al, 2004), User-centered design (UCD) is a design method in which the user collaborates with the designer as a partner throughout the process. The goal of UCD is to aid development and ensure that users can use the product as they choose with minimal effort to learn how to use it.

Next is to determine who are the participants? Eason (1987) offers three types of users: primary, secondary, and tertiary. Primary users are those who use a lot, really need to use the product; secondary users are those who will use the product from time to time or who use it through an intermediary; and tertiary users who will be affected by the use of the product.

First, investigating their needs through the analysis of habits and preferences, researchers can develop solutions designed for user evaluation. Design solutions can be simple pencil and

paper drawings in this starting stage. Then when the prototypes are designed, the designers will pay attention to the user's assessment of usability. Measurable usability criteria such as: performance, learnability, memory and satisfaction with the product. The above processes can be repeated over and over to update a good product.

❖ Goal-oriented

Goal-oriented design refers to the behavioral, visual, and physical design of a product to achieve a goal (Goodwin, 2009). The Goal-oriented design process is divided into the following six steps:

- Research: collect qualitative data from users through interviews, focus groups. Analyze data collected from stakeholders to determine their requirements.
- Model: can be divided into two parts. First, define the model, design scenario from the beginning. In part two, identify a user pattern that improves through usage.
- Requirements Definition: a context scenario should be defined to help define the links between the user model and other models.
- Framework definition: Need to create the overall product concept (conceptual design) and visual design of the product. In this stage you can create a prototype of the product: low fidelity, mid fidelity, high fidelity.
- Refinement: perform refinement and create design documentation: guidelines, evaluation, testing.
- Support development: no matter how clear the goal, things can change during development. Therefore, regular support is required so that the overall quality is not affected (Goodwin, 2009).

III. Dimensions of interaction design

Interaction design is seen as shaping our lives through digital works for work and play. It is classified by dimension: 1-D, 2-D, 3-D, 4-D (Smith, 2007). It corresponds to: words, visual representations, physical objects or space, time. During development it was added a 5th dimension by Kevin Silver as 5-D Behavior (Silver, 2007). These aspects are detailed below:

- ❖ **1-D Words:** The language used should be the most appropriate description of the operation, simple, easy to understand, and highly consistent. (Smith, 2007). At the same time, the words used must meet the user-centered principle, so the words are used not for the designer to understand but for the end user to understand and use. We can be based on culture, language, religion, age,...



Figure 1: 1-D Words

- ❖ **2-D Visual Representations:** It includes components such as art, typography, graphics, and icons; it is no longer just basic text (Smith, 2007). Even if there is no text explaining a picture, we can still realize through the viewpoint space that the layout's content has highlighted its meaning. The application of visual images to the design is also more powerful than the use of words.

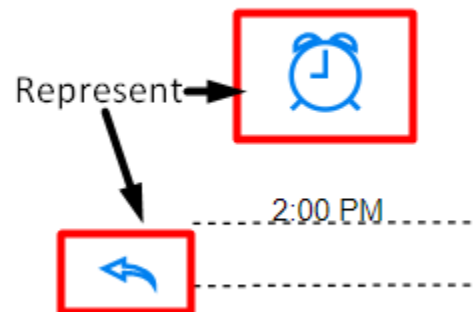


Figure 2: 2-D Visual Representations

- ❖ **3-D Physical Objects or Space:** refers to the physical or spatial form with which the user can interact. objects that people can clearly grasp and touch, such as a computer mouse used to move and select necessary actions on the computer screen. The spatial factor here, maybe the multi-touch screen on smartphones is now a new way for users to interact with the product. The first 2 dimensions and these help enable user-device interaction (Silver, 2007).

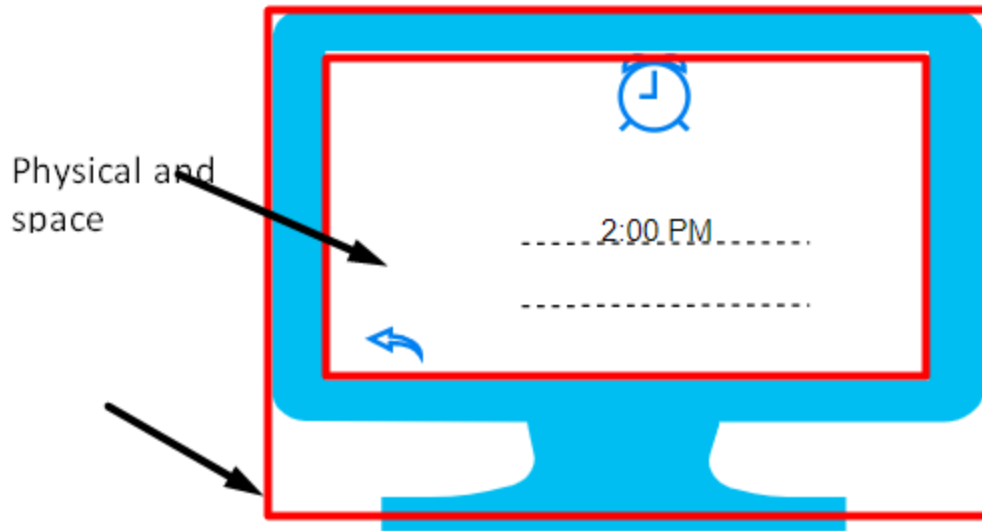


Figure 3: 3-D Physical and Space

- ❖ **4-D Time:** To put it simply, the elements of sound and animation play an important role in interaction design because it will bring a sense of comfort and a good response message in accordance with the wishes of the user. In addition, the time factor also greatly affects the user experience.

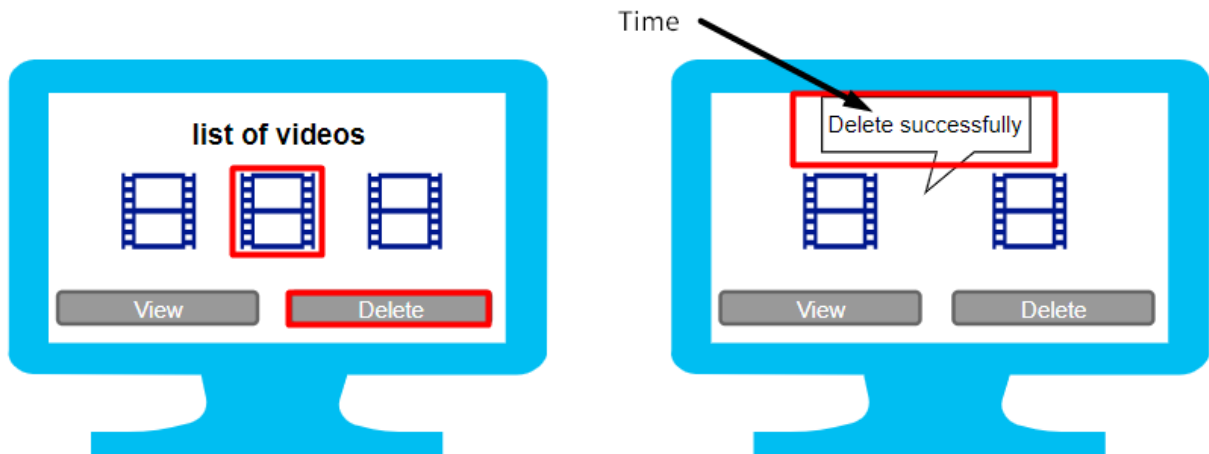


Figure 4: 4-D Time

- ❖ **5-D Behavior** It encompasses both action and presentation, as well as response. The user takes action by clicking on something in the presentation layer that triggers a response (Silver, 2007).

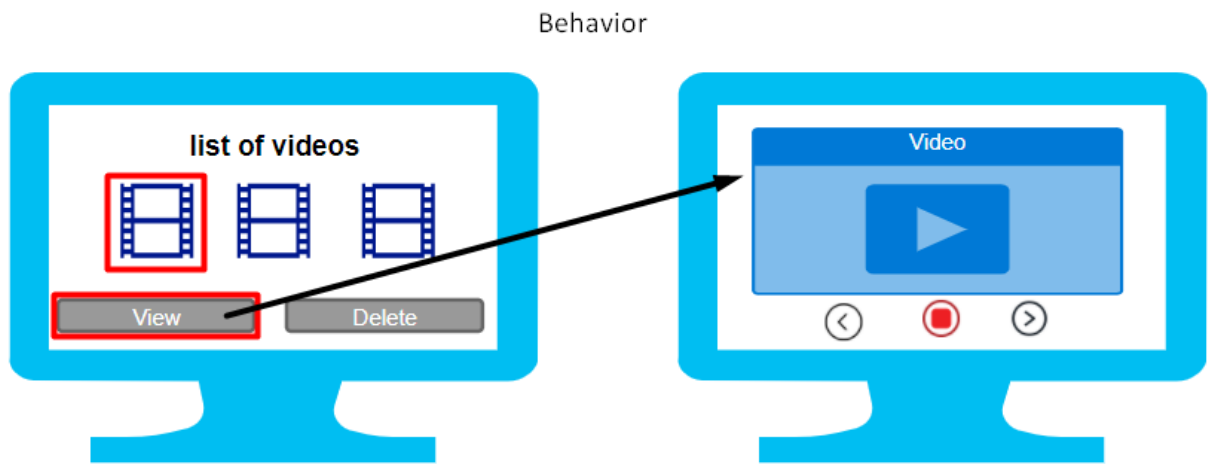


Figure 5: 5-D Behavior

IV. Interaction design theory and scope prototype

1. Cognitive psychology

Cognitive psychology is a branch of psychology that studies how people think, remember, learn, dream, make decisions, see, read, write, and talk (Preece et al, 2015). When using cognitive psychology, it can be classified according to the following processes:

- ❖ Attention
- ❖ Perception
- ❖ Memory
- ❖ Learning
- ❖ Reading, speaking, and listening
- ❖ Problem solving, planning, reasoning, and decision making (Preece, 2015).

Below I will describe some important processes such as: attention, perception, memory.

Attention: This is the process of choosing what to focus on in relation to our senses. How easy or difficult this process is depends on whether we know exactly the information we need (Preece et al, 2015). For example, when we turn on the TV and there is a football game, what is the first thing we notice? will of course be the current score of the match.



Figure 6: Football scores are noticed

Perception: Perception refers to how information is received from the environment through the senses and then transformed into experience (Roth, 1986). It is important in interaction design to present information in the most accessible way through the following recommendations :

- ❖ Use symbols to express meaning
- ❖ separate the layout of each section by space, group
- ❖ easy to understand, easy to distinguish
- ❖ Contrasting colors highlight important information.

Black Hills Forest Cheyenne River Social Science South San Jose Badlands Park Juvenile Justice	Peters Landing Public Health San Bernardino Moreno Valley Altamonte Springs Peach Tree City	Jefferson Farms Psychophysics Political Science Game Schedule South Addition Cherry Hills Village	Devlin Hall Positions Hubard Hall Fernadino Beach Council Bluffs Classical Lit
Results and Stats Thousand Oaks Promotions North Palermo Credit Union Wilner Hall	Highland Park Machesney Park Vallecito Mts. Rock Falls Freeport Slaughter Beach	Creative Writing Lake Havasu City Engineering Bldg Sports Studies Lakewood Village Rock Island	Sociology Greek Wallace Hall Concert Tickets Public Radio FM Children's Museum
Performing Arts Italian Coaches Mckees Rocks Glenwood Springs Urban Affairs	Rocky Mountains Latin Pleasant Hills Observatory Public Affairs Heskett Center	Deerfield Beach Arlington Hill Preview Game Richland Hills Experts Guides Neff Hall	Writing Center Theater Auditions Delaware City Scholarships Hendricksville Knights Landing
McLeansboro Experimental Links Graduation Emory Lindquist Clinton Hall San Luis Obispo	Brunswick East Millinocket Women's Studies Vacant News Theatre Candlewood Isle	Grand Wash Cliffs Indian Well Valley Online Courses Lindquist Hall Fisk Hall Los Padres Forest	Modern Literature Studio Arts Hugher Complex Cumberland Flats Central Village Hoffman Estates

Figure 7: apply the use of contrasting colors and spaces to easily distinguish information (Preece, 2015)

Memory: Memory refers to recalling different types of knowledge and using them for specific purposes. Of course we cannot remember every word we see, hear, do, .. but only a few important things (Preece et al, 2015). Things that are repeated, compared with other things, or discussed and explored are easier to remember than things we want to keep in our heads.

2. Definition of Interaction Design

Interaction design is to create a portal that helps users communicate with the product in the most easy and convenient way. The focus of interaction design is on practice and no specific design methodology can be applied to all situations. (Preece et al, 2015).

3. User experiences

User experience (UX) is main point of interaction design. It refers to how people perceive a product as the joy or satisfaction of seeing, holding, or using that product (Preece et al, 2015). User experience happens whenever people use the product. we cannot directly designate user experience as emotional. but we can create user experience by creating designs that evoke that experience. There are many aspects that affect user experience, they need to be considered before designing such as: usability, functionality, aesthetics, content, look and feel, and appeal and feel (Preece et al, 2015).

4. Design principles

Design principles were created to assist designers as they design experiences for users. They suggest to the designer what is necessary to do and what to avoid in the interface (Sharp et al 2019). Shape (2019) set out some general principles in design:

- ❖ **Visibility:** simply visibility of functions, their usage and location. It will be a minus point when users use the product without knowing what features it has as well as how to use this feature.
- ❖ **Feedback:** Try to imagine that when you play the game, it is fine until there is a phenomenon of lag and freeze. You will not easily accept, and do not know how to tell the producer that this game is having problems. And suddenly having a place where you can submit those issues for review and resolution would be a lifesaver.
- ❖ **Constraints:** Constraints refer to defining ways of restricting the types of interactive user actions that can take place at a given time (Sharp et al, 2019).
- ❖ **Consistency:** This refers to uniformity in the design. For example, when users approach and learn something and use it for all, this principle will help the design to be optimized and easy to use.
- ❖ **Affordance:** This principle refers to a property of an object that lets people know how to use it (Sharp et al, 2019).

5. Scope prototype

Firstly, I will design a system to access the music library and select the songs to enjoy them. The second is the navigation system, which is a function that accompanies the music system, helping guide the driver to the desired destination. Below I will conduct research to provide proofs of concept for these system interactions, as well as design prototypes for them.

V. Experimental study

1. methods of reasearch

Here I will use the primary research method to design my interactions. Primary research is often based on the principles of the scientific method. The scientific method has the following basic principles: observing, making assumptions, and testing those assumptions (Carey, 2011).

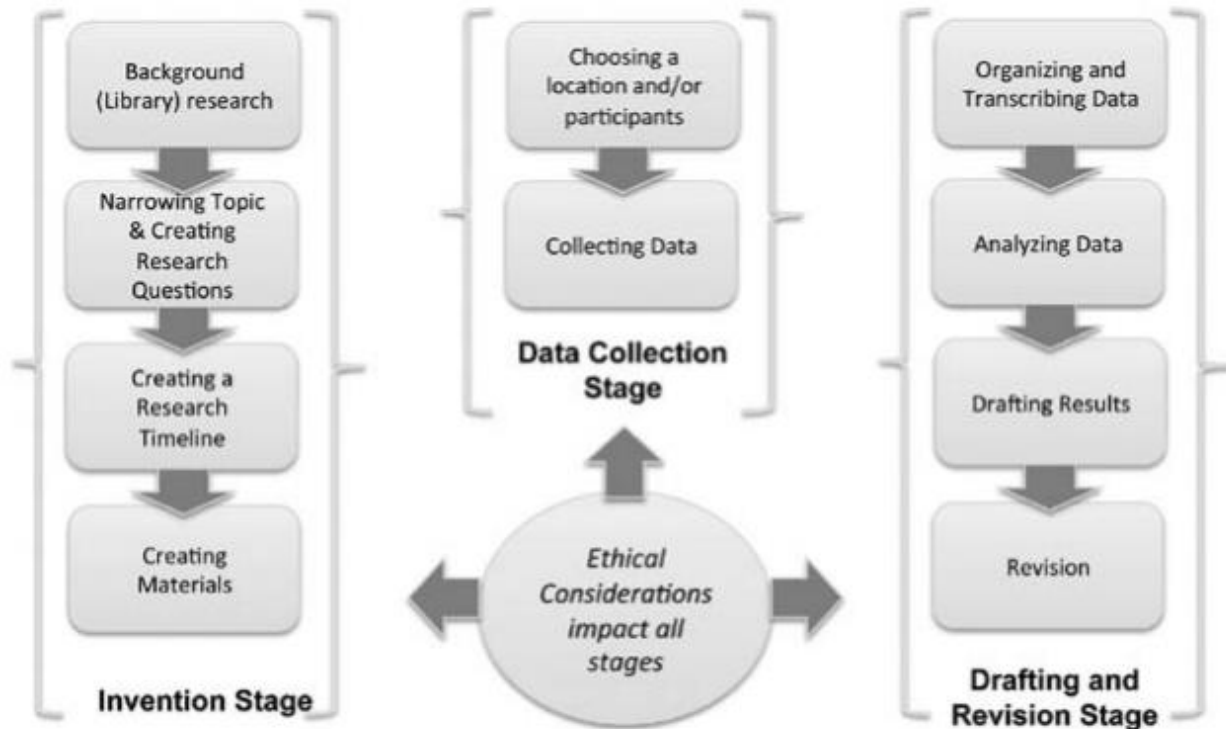


Figure 8: The research process (Driscoll, 2011)

2. Questionnaire and participants

Do you want the messages on the system to be summary or detailed?	Summary		Details	
How do you want the function keys to be represented?	Icon	Icon and text		Text
How long does it take to implement the features you want?	Immediately	Awhile	Other	
Does the navigation system need to integrate voice recognition?	Very necessary	Necessary	Unnecessary	Very unnecessary

Participant: The survey participants are also the group of users of my system, so they play an important role that directly affects the quality of the system. Therefore, in order to select subjects to participate in the survey, I base on a number of factors to select the appropriate subjects:

- ❖ Age: the price of cars is relatively high, so it is usually only people with stable economic conditions that can own and can own in the near future. So the age I chose to collect data is from 25 years old and up.
- ❖ Experience: Participants have experience many similar systems such as: music system, phone navigation. It's also possible that they are longtime drivers and they are quite familiar with other systems in the car so it shouldn't be difficult to give me the information I need.
- ❖ Level of knowledge: Those who have knowledge in the field of graphic design, interface or human interaction research.

3. Data analysis method

After the data is collected through the survey method, it will be analyzed to draw conclusions for the original purpose. Here I will present the data analysis methods that will be applied to this study: quantitative and qualitative.

Qualitative work with natural languages, they are often based on intentional, opportunistic cases. This methods focus on specific individuals to provide in-depth analysis such as comments and assessments. While quantifying work the numbers, statistics table. Quantitative work has greater possibilities, when problems are identified more generally (Wilkerson et al, 2017). There is a point of view given by (Preece et al, 2015), data when collected in quantitative form can still be analyzed qualitatively by making comments about them.

4. Project management

The Software Development Life Cycle (SDLC) is a methodology for designing, building, and maintaining information for software development (Bassil, 2012). here I will use waterfall model to develop my product. The phases in this model are: Analysis, Design, Implementation, Testing, Maintainance.

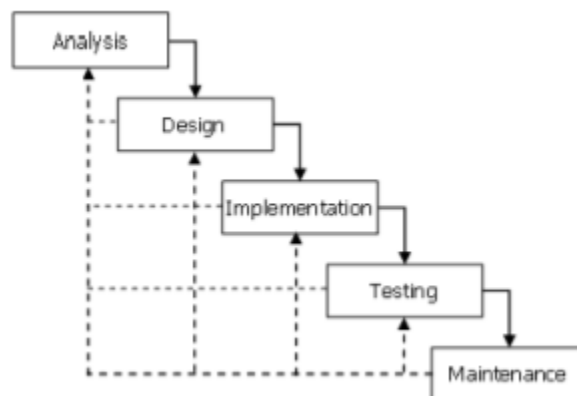


Figure 9: The Waterfall model (Bassil, 2012)

Below I will create a wbs chart for the work I have to do in each phase of this model. At the same time, we will create a gantt chart to better manage time for my products.

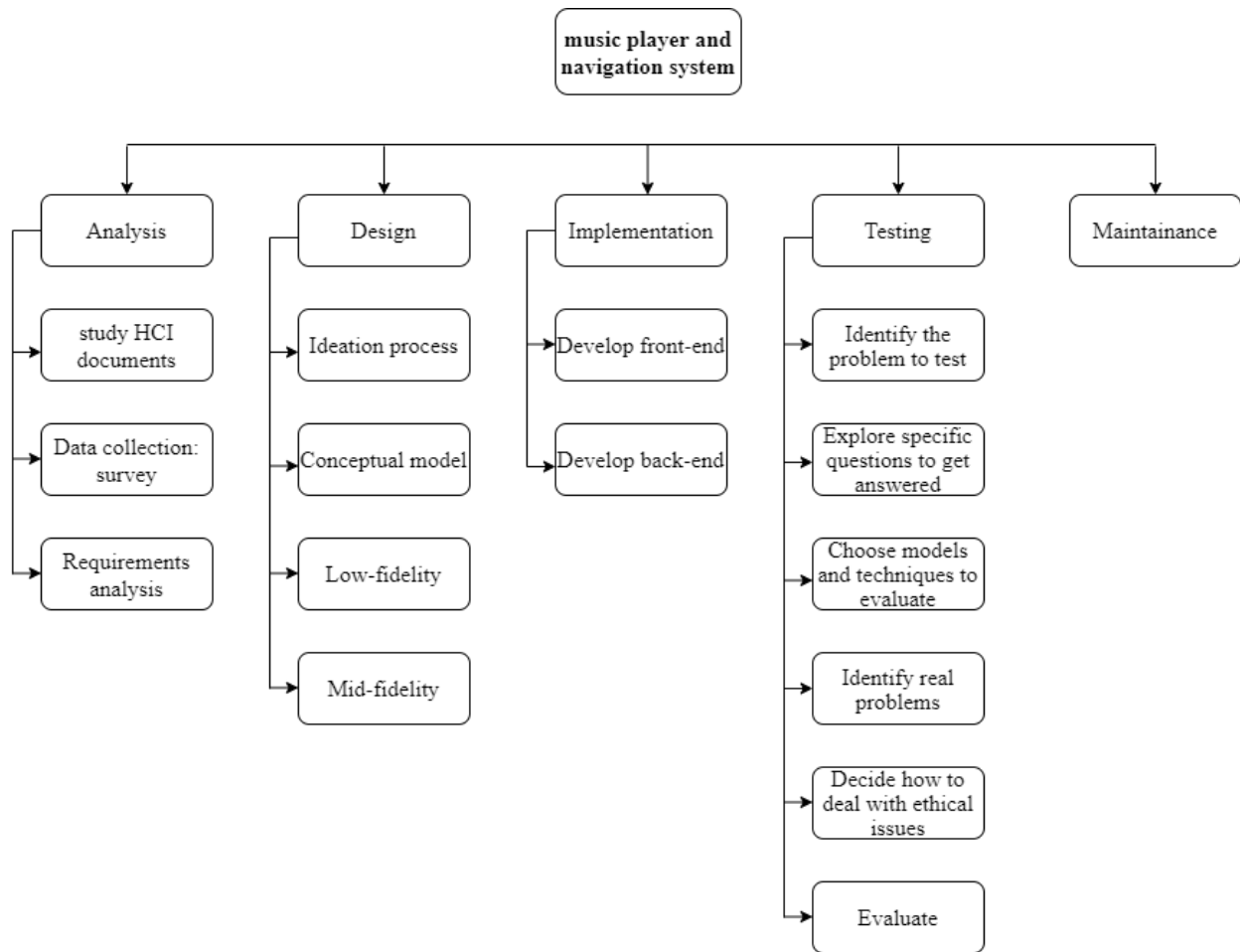


Figure 10: WBS for music player and navigation system

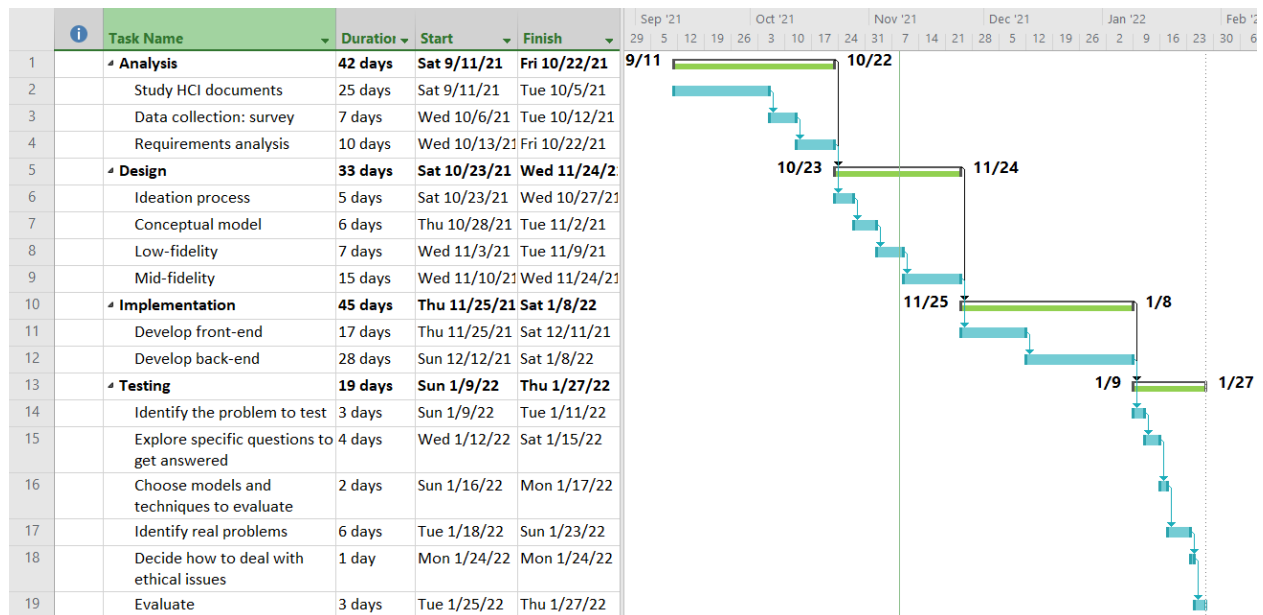


Figure 11: Gantt chart

VI. System design

1. Assumptions for design

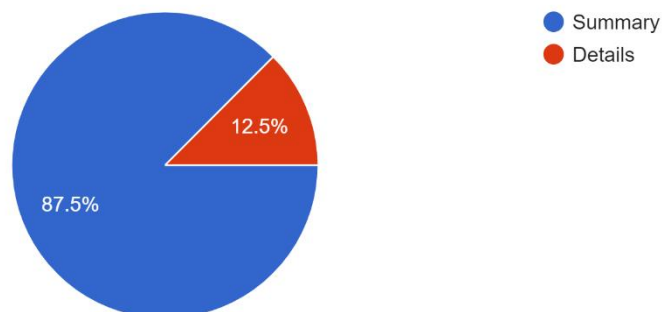
- ❖ The color scheme uses a dark color palette to prevent strong light from entering the driver's eyes and make the lighting system more beautiful.
- ❖ Icons may be preferred over traditional text.
- ❖ Voice recognition will be needed when they don't have time to write where they want to go, voice will solve the problem instead.
- ❖ Allows users to search for locations, zoom in, zoom out

2. Results from the survey

I did a sample of 24 people who responded to 1 of the 3 requirements I made earlier.

Do you want the messages on the system to be summary or detailed?

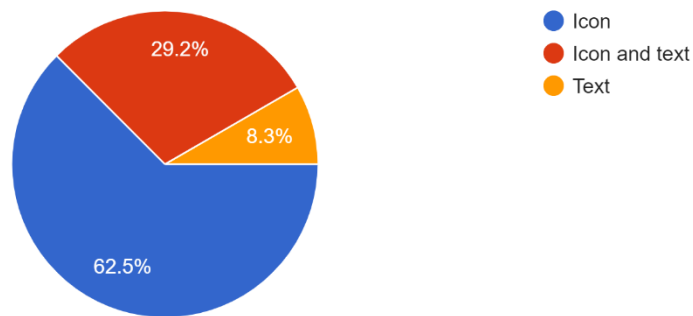
24 responses



Most people expect system messages to be brief. This means that people don't want to spend a lot of time reading all the details, they just want to know what the purpose of this message is, such as: delete music, close the app or restart,...

How do you want the function keys to be represented?

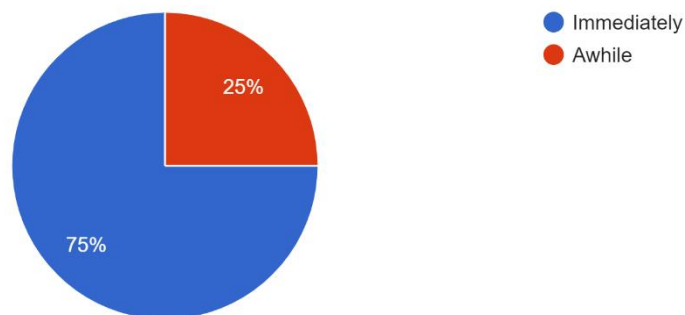
24 responses



When asked about using text and icons to represent functions, people almost don't want to use plain text (only 8.3% want it to be plain text). The rest people mainly (62.5% and 29.2%) want to use icons or accompany it with brief text to make it easier to recognize. Maybe those who want icons with text they are afraid of being difficult to access if the functions are only represented by images, but they do not want plain text that is not very aesthetically pleasing.

How long does it take to implement the features you want?

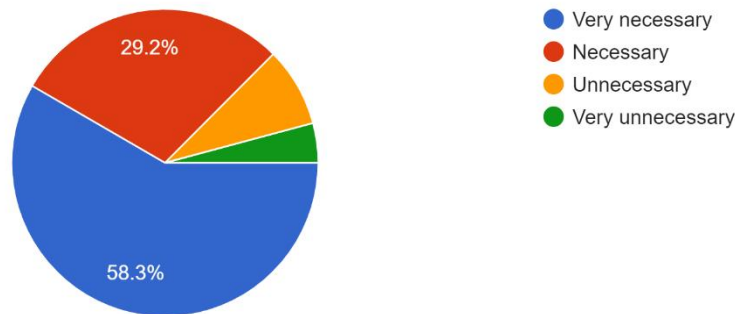
24 responses



The majority of participants (75%) considered the response time between features to be the shortest. Still, 25% of the participants wanted some time between features. Perhaps that will give them a sense that these functions are being implemented rather than something too simple.

Does the navigation system need to integrate voice recognition?

24 responses



When asked about adding voice recognition to the navigation system, all participants said it was essential in the car's system. It is easy to see that when driving and wanting to use the navigation system to get to the desired destination, you have to write the desired address in the search bar. Maybe we will have to stop the car and write down where we want to go and then move on. However, it would be nice when you don't need to stop the car and just say where you want to go.

3. Applying five dimension to prototype design

1-D Words: With the design of the car music system and navigation - the messages used on the system present a summary and full meaning of the action. Information provided must be easy to understand, without the use of professional or academic terms.

2-D Visual Representations: Some functions and actions will be changed from text to icons for easy use even while driving. The color uses dark tones to avoid blinding the driver.

3-D Physical Objects or Space: The system will use a multi-touch screen, the space for buttons should not be too small for easier operation instead of choosing absolute accuracy. Functions should be placed in the most convenient locations and by common convention, for example, buttons to close functions are located in the right corner of the screen.

4-D Time: I will try to design my system to be simple and time to functions will be short and feel real.

5-D Behavior: Functions that work when clicked must have results, such as: start, switch tabs. Holding hands on the map can move the sides.

VII. Usability testing

1. Usability test planning

According to (Preece et al, 2002) provides an assessment framework called the DECIDE framework, which includes the following steps:

- ❖ Identify the problem to test: check all user requirements, test the responsive interface for the end user, the impact of technology on the actual product.

- ❖ Explore specific questions to get answered: The questions must be detailed to satisfy the original intent.
- ❖ Choose models and techniques to evaluate: choose the appropriate method that meets a number of factors such as time, geography, it can be the observation method.
- ❖ Identify real problems: can refer to as participant selection, budget, schedule.
- ❖ Decide how to deal with ethical issues: referring to user privacy
- ❖ Evaluate: mention some factors, such as: reliability and validity, biases.

2. Preparation

User testing requires that the test environment be designed to be authentic, controlling for unwanted factors and interference that could distort the results. These facilities typically include a laboratory, with recording equipment and products under test, and an observation room for assessors (Preece, 2002).



Figure 12: The evaluator observes the participant on a screen and through a one-way mirror (Preece, 2002).

I need to set up a place that looks just like a real car, complete with a music and navigation system that I designed. Testers will have the sensation of driving in a real-world setting and using the systems I've created. The assessors should have their own observation room, separated from the laboratory by a one-way mirror so that they are not visible by those doing the experiment. It is important to set up observation, video, and video recording equipment on the vehicle in order to save data for later evaluations.

3. Observation

Observation is a useful method by which reviewers can check the ease of use of a product. It can be assessed by observing videos, animations, still images and audio recordings collected from users (Preece et al, 2002). For example, with video observation, it is possible to see the number of times the user touches the function button, the force of the touch is strong or light sometimes can also know the user's attitude when they use the product. Or the time they spend to experience the product is too short also shows dissatisfaction.

3. Key components in test questions

Five main component according to (Nielsen, 2012): learnability, efficiency, memorability, errors, satisfaction. Some of the questions I would use to test my products are:

- ❖ How easy is it for users to use the features I've designed on the infotainment and navigation systems?
- ❖ Are the features of the entertainment and navigation system as desired by the user?
- ❖ How do users feel after using the product?

VIII. Conceptual design

1. Idea process

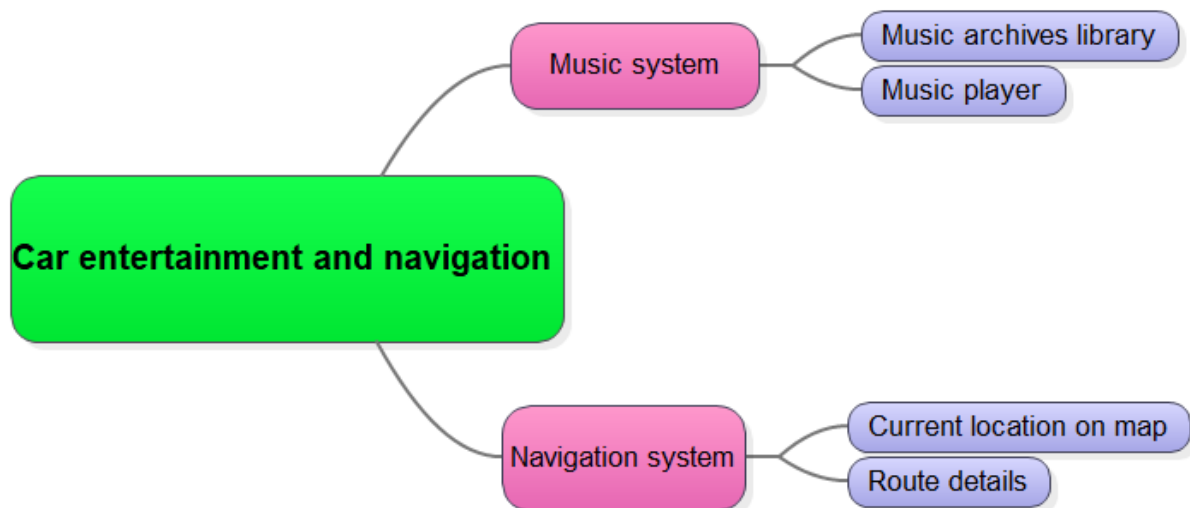


Figure 13: Idea process for car entertainment and navigation

2. Conceptual model

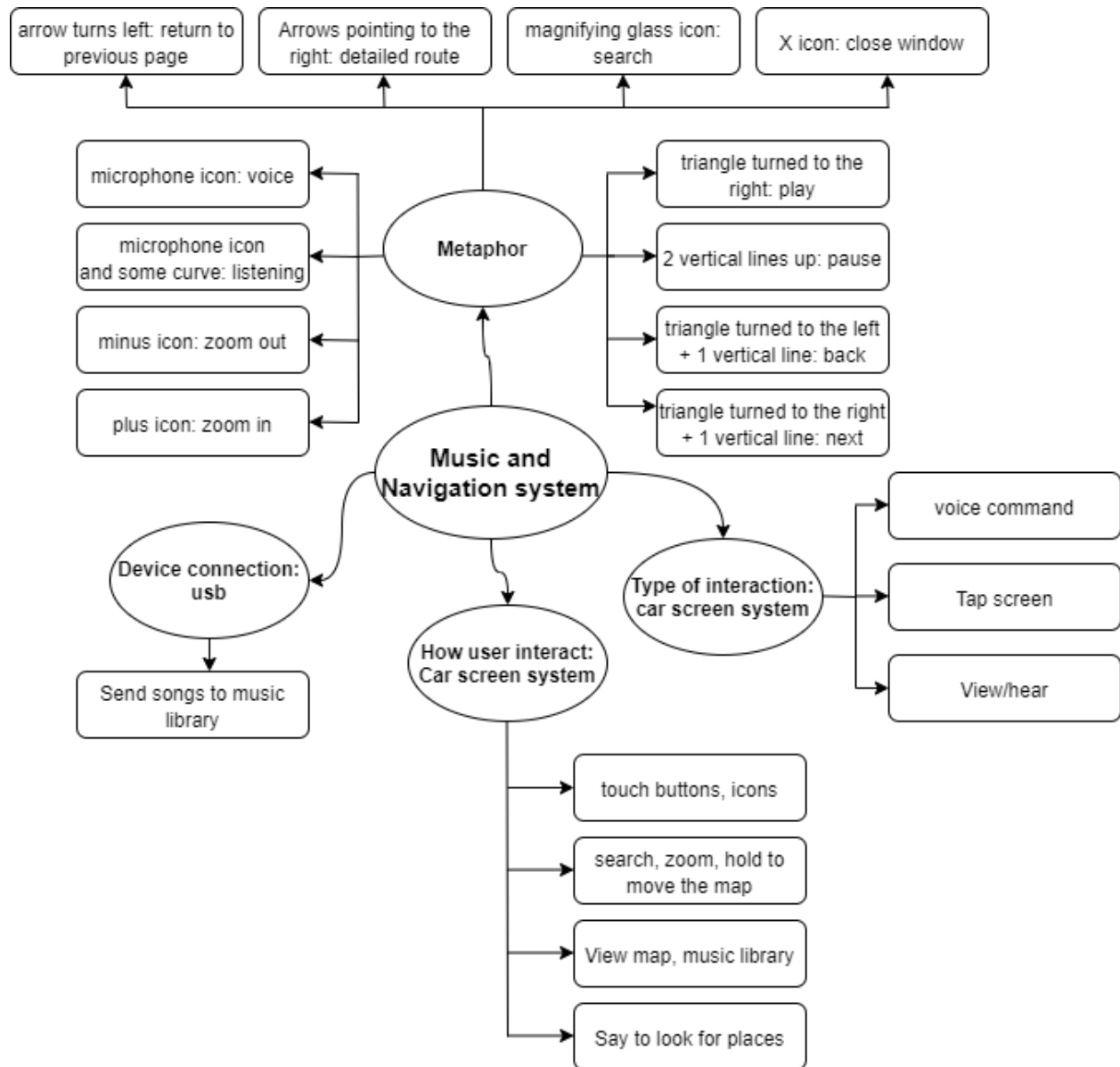
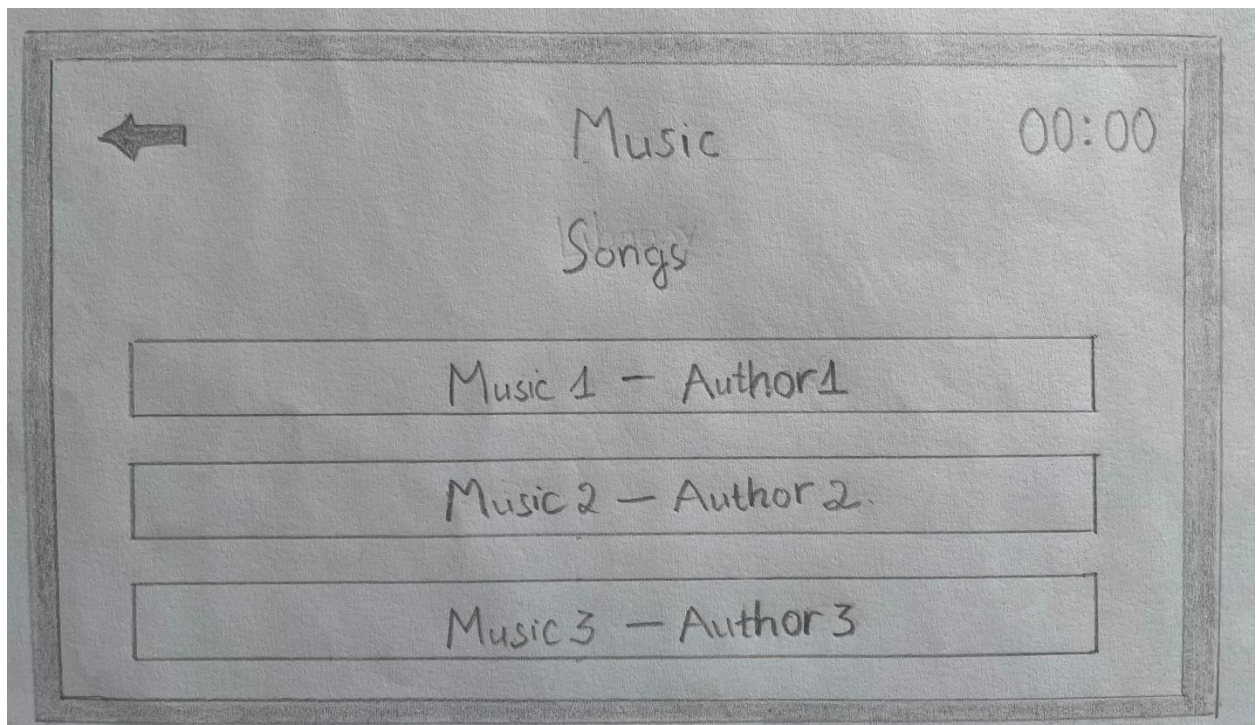
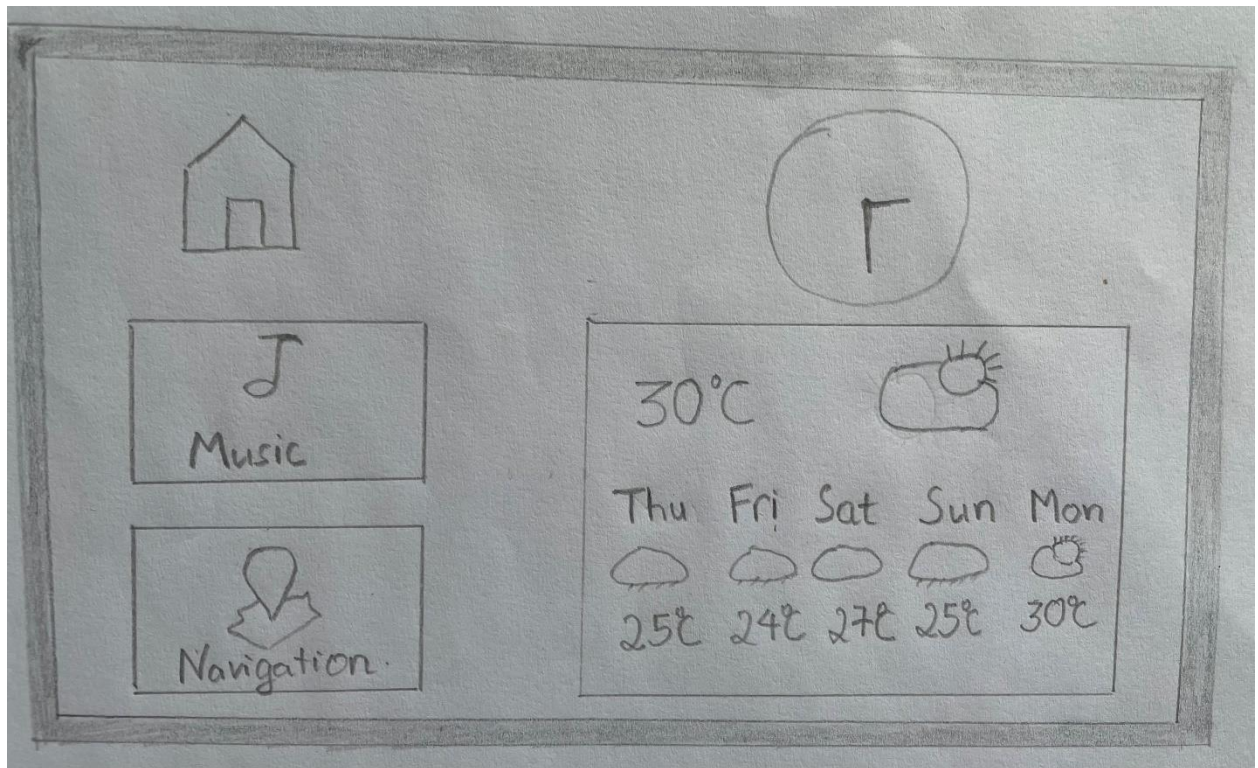
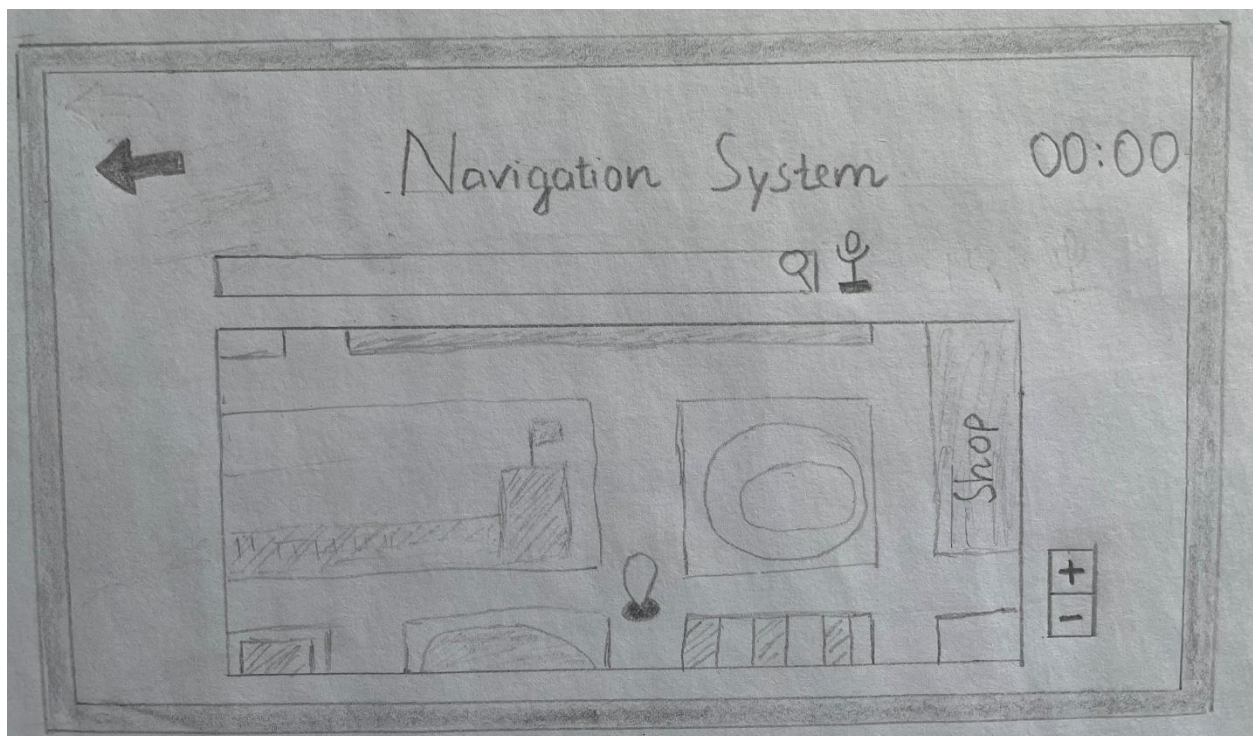
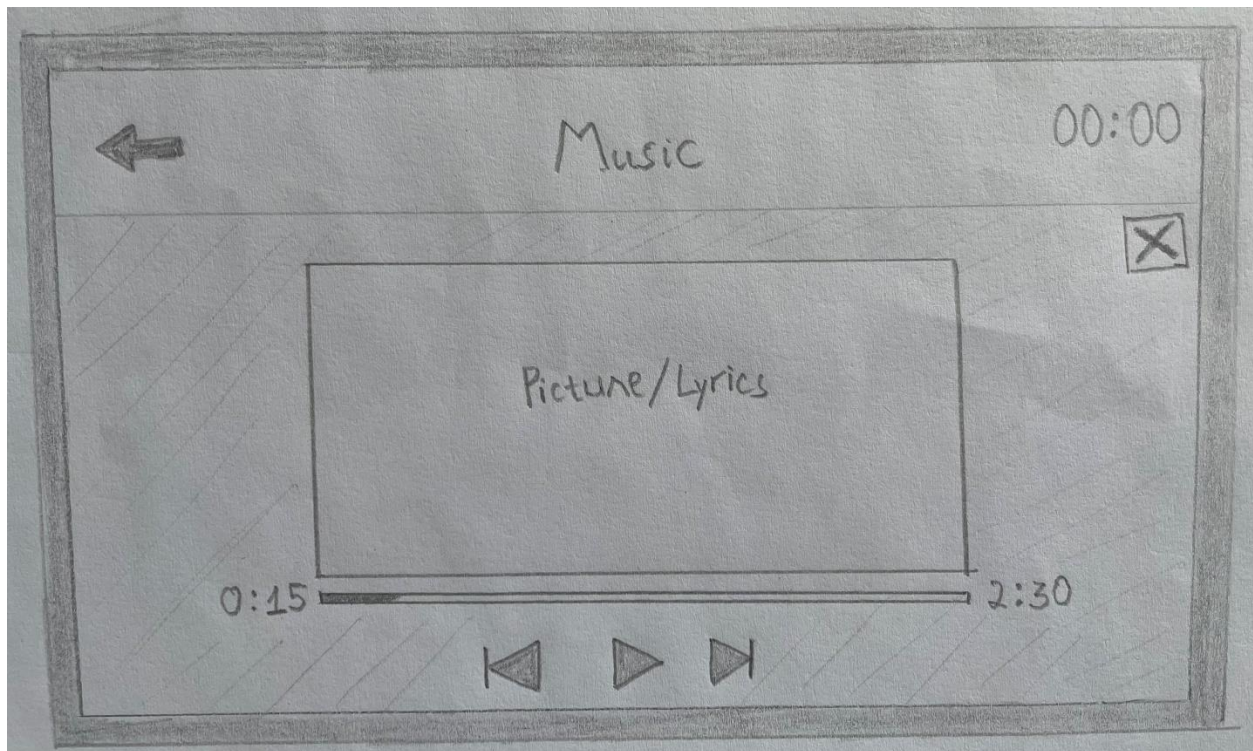


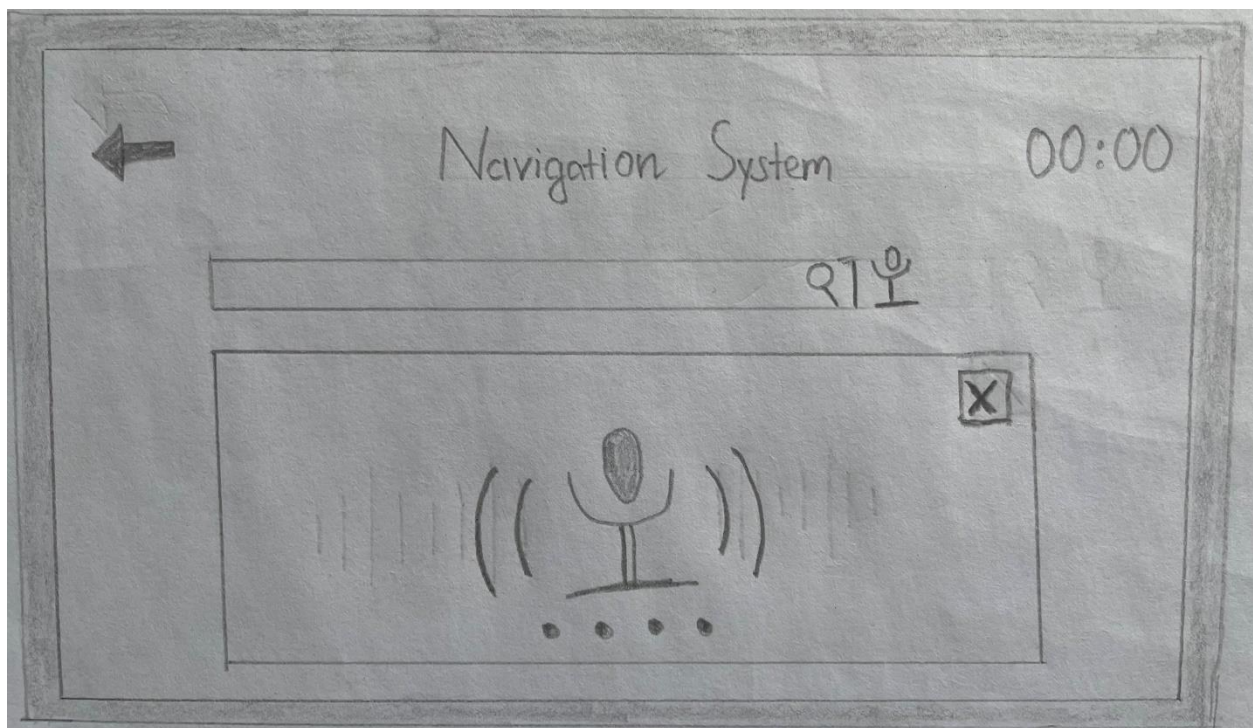
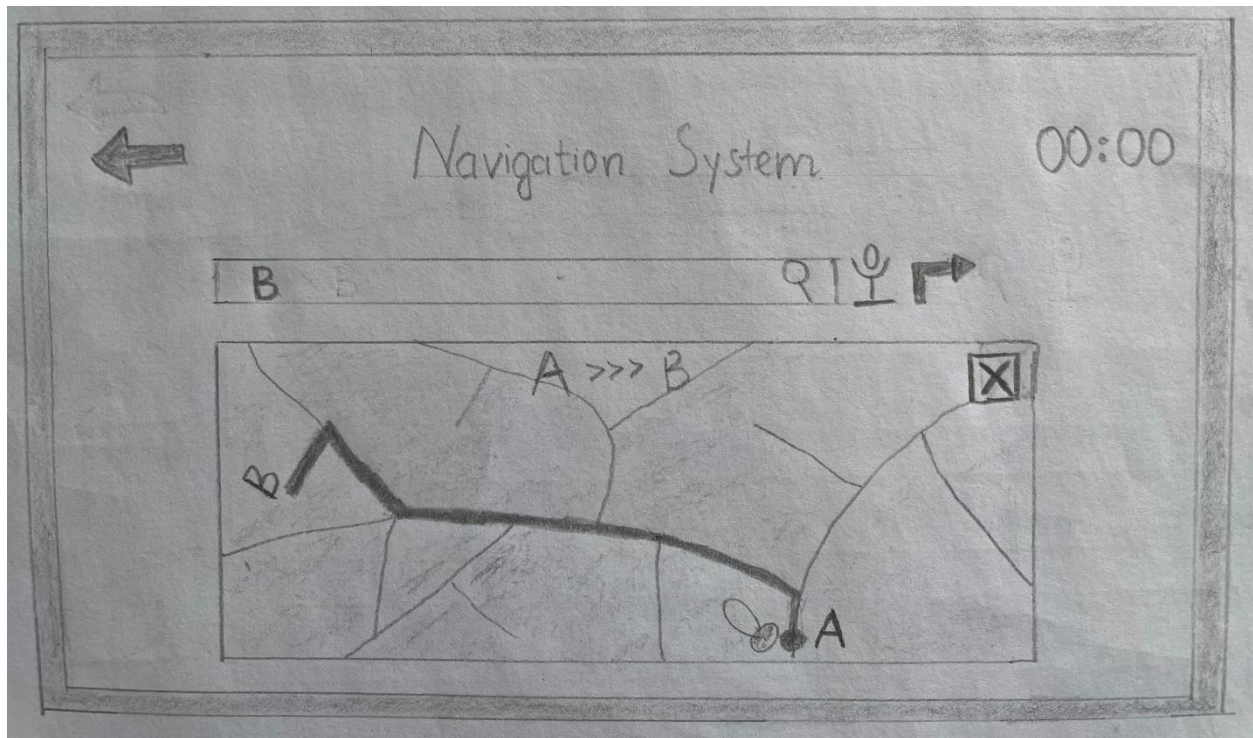
Figure 14: Conceptual model for music and navigation system

IX. Prototype creation

1. Low-fidelity demonstration



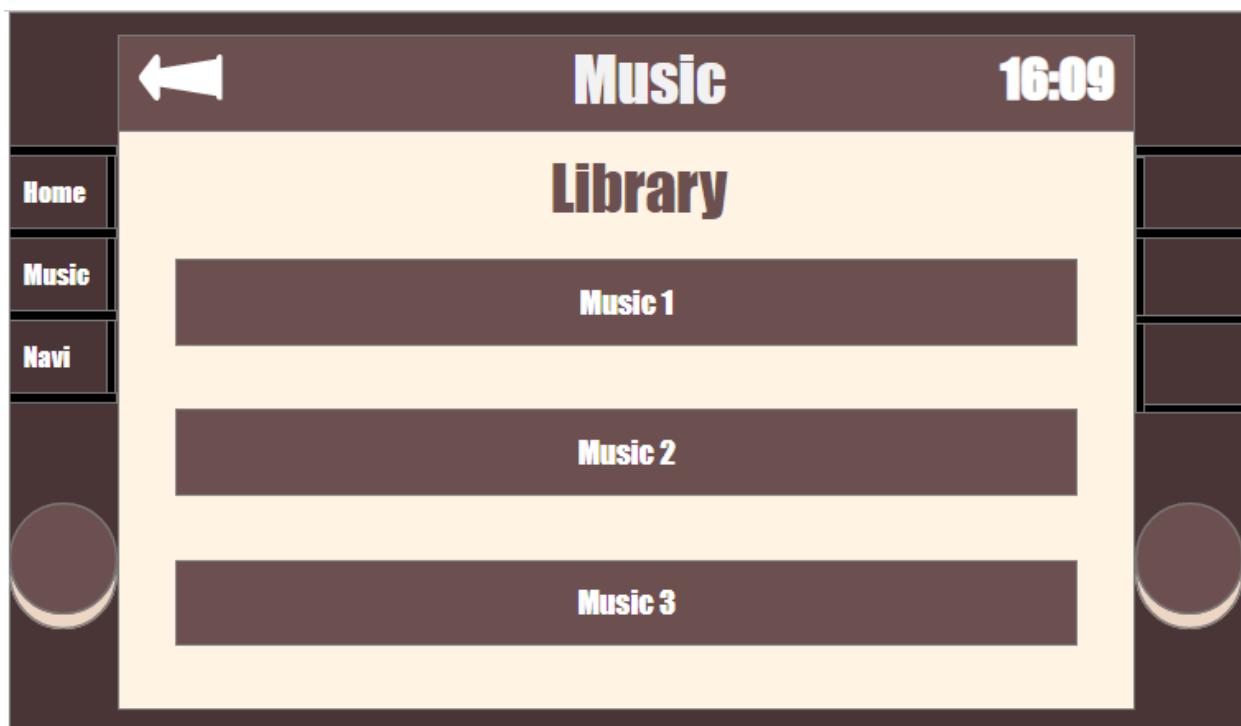




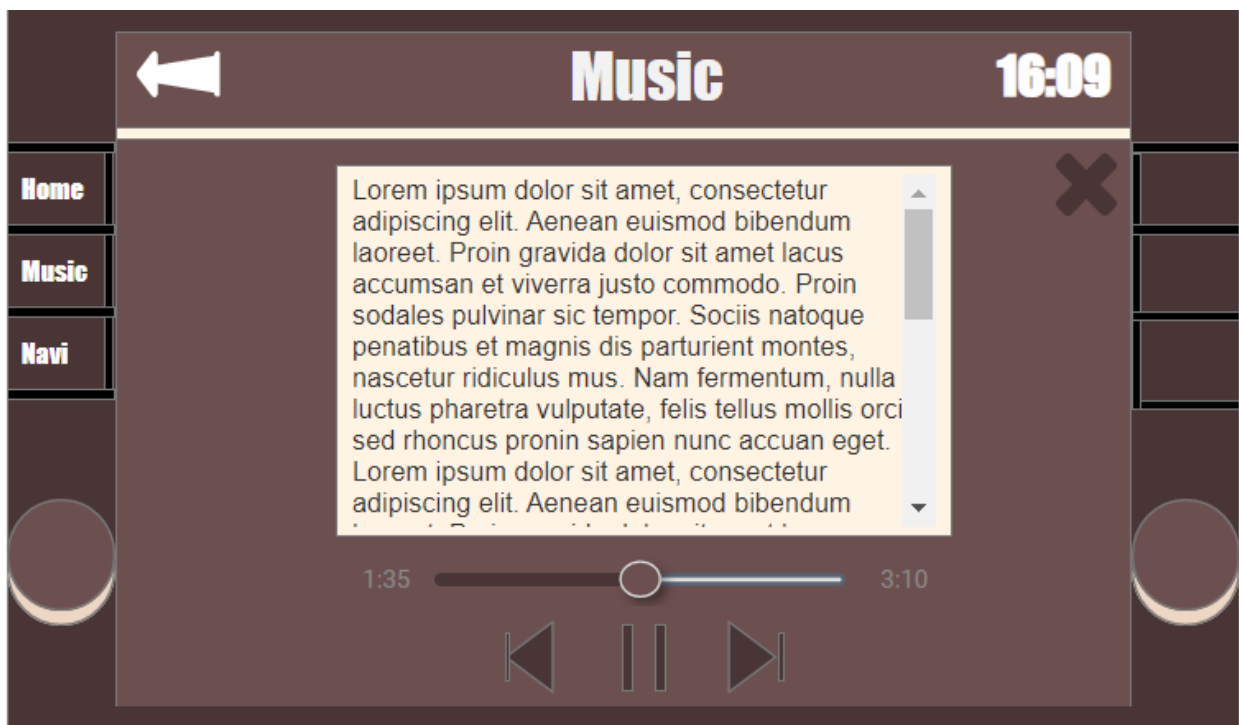
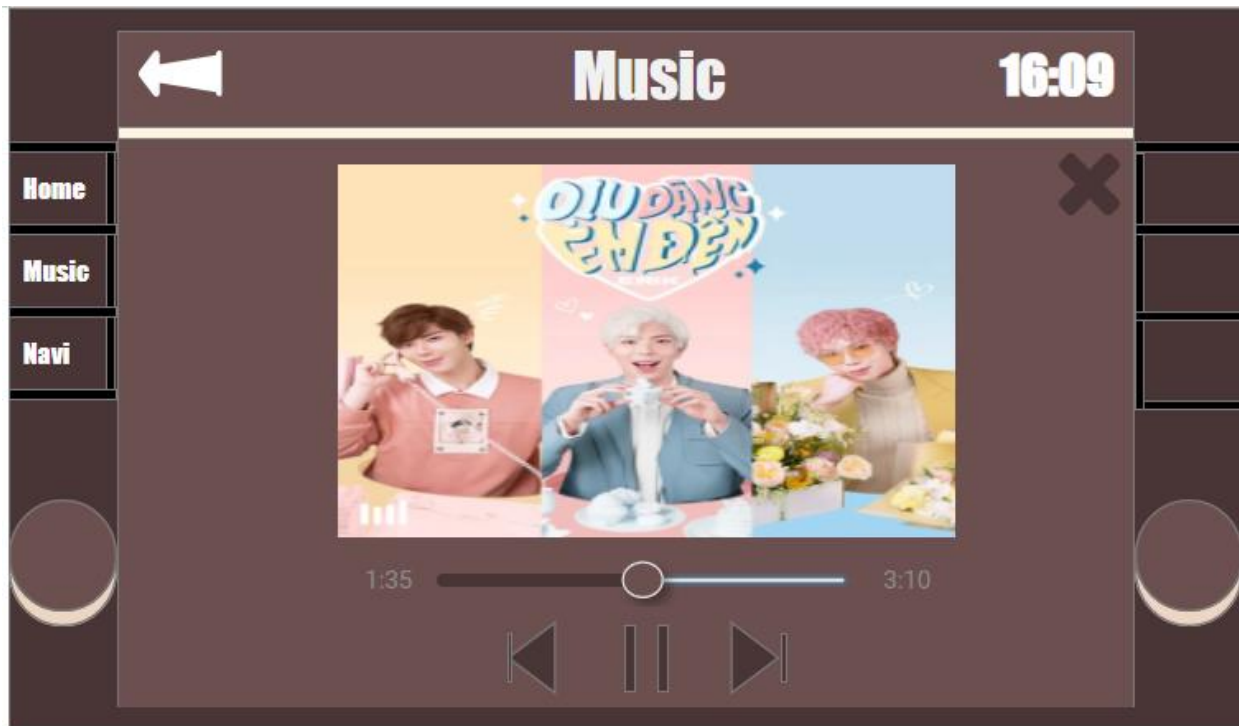
2. Mid-fidelity demonstration
- ❖ Home page



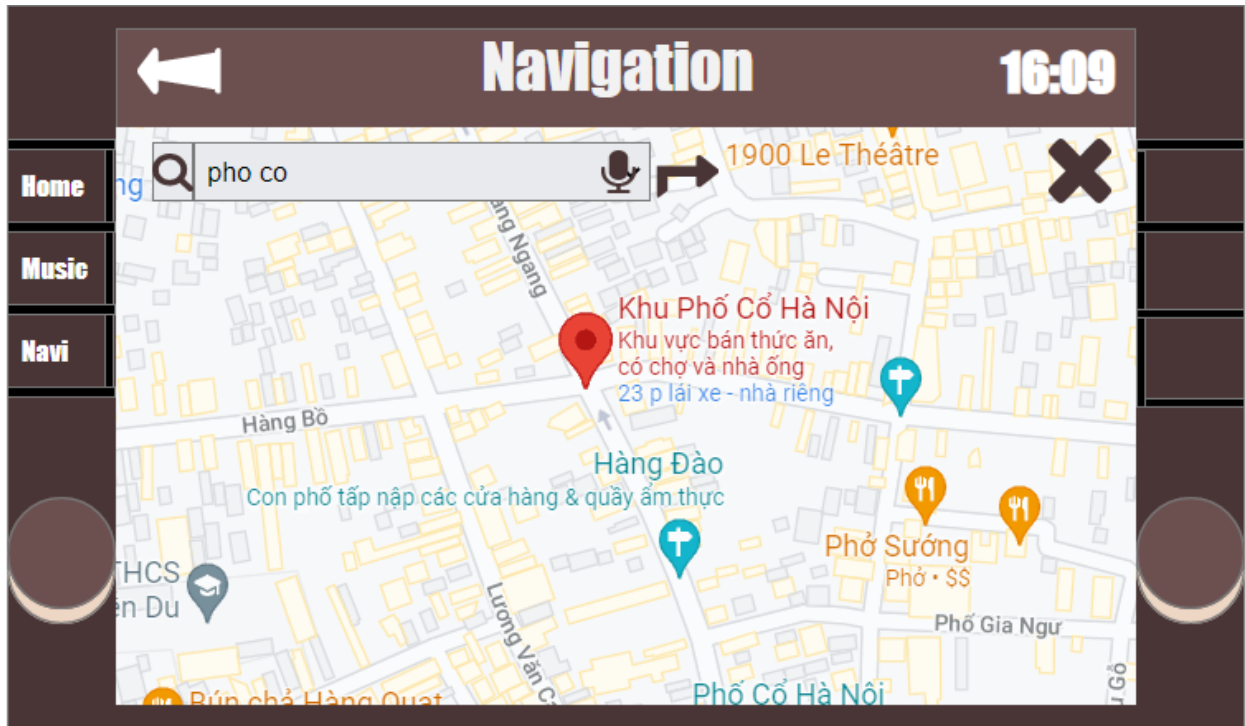
❖ Music library



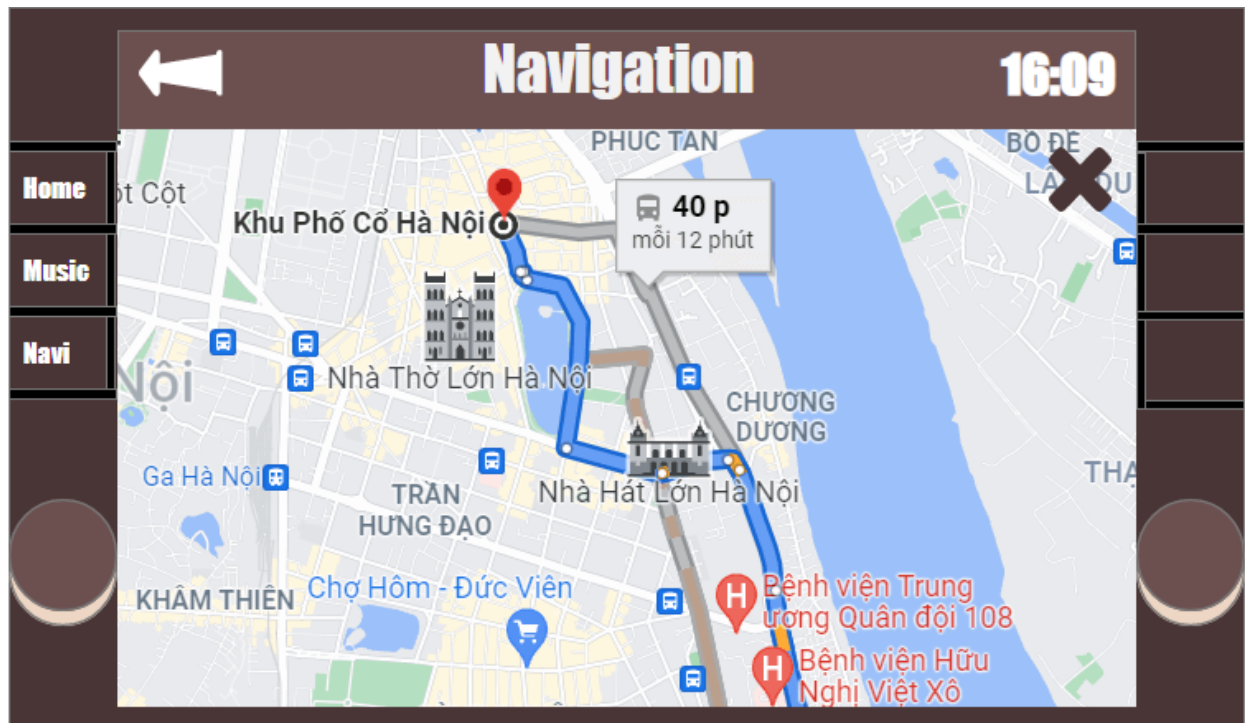
❖ Player music



❖ Navigation system



❖ Redirect



❖ Voice command



3. Axure file link

<https://drive.google.com/file/d/1r7b0VfkvT0EvRYOnFx2YP4YTA4VbX4k/view?usp=sharing>

X. Conclusion

Because the time of the course is not enough for me to complete the desired product, it is only at the design stage^{27.1} (mid-fidelity diagram). Even so, I also have a clear plan for the next steps to have the actual product. As well as providing a plan and method for testing the usability of navigation and music products.

In the future, car navigation and music systems will do the rest, as I mentioned in the gantt chart above. First, after the product is designed, it will come to the stage of developing the interface and processing system. We will then proceed with the usability test plan following the steps I outlined in section VII. However, it would be expensive to prepare a lab for testing, so I may have to seek help from donors to do this. The product will be carefully evaluated and analyzed to see if it meets factors such as ease of use, meets requirements, is easy to remember, etc., before it is delivered to end users.

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Index of comments

27.1 this conclusion is vague, the figure above is not a Gantt chart.