Bachelor's thesis

User to car connecting In-Vehicle-Infotainment system design for the Biofore -concept car

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Abstract

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The primary aim of thesis was to create an In-Vehicle-Infotainment system that connected the user to his or her car. The target was the Biofore -concept car, a technology demonstration platform created as a part of a Tekes- Technology and research project. The secondary aim was to create a green element into the In-Vehicle-Infotainment system.

This is an operational thesis, in which different phases of the project and how the process progressed are explained. The thesis strongly reflects the design work and the decisions made during the project that are supported by the guiding and referring material.

The end product of the project was the graphical user interface with it's designed features that were displayed in the concept car at the 2014 Geneva motor show. Among the features were a "Biofore" smartphone application, a "Greenness game" and a navigation function.

With the "Biofore" smartphone application one could for example change the dial layouts and modify the interior lighting. The purpose of the "Greenness game" was to guide the users of the car to a more economical way of driving. Among it's features was a program that analyzed driven trips, that after the drive showed the entire driven distance as a map image, from which one could see their way of driving. Because of the tight schedule the "Greenness game" was not developed to be one of the final features in the concept car.

In connection to studying the reference material a graphical user interface design guide was created. The accuracy of the design guide could not be tested because of the project timetable, but the contents of the design guide were based on reliable sources.

Keywords	UI, GUI, UX, IVI, Smartphone

Tiivistelmä

Tekijä(t)	Ville Hela-Aro
Otsikko	Käyttäjän autoon yhdistävän auton sisäisen informaatio- ja viihdejärjestelmän muotoilu Biofore-konsepti autoon
Sivumäärä Aika	95, sisältäen yhden liitteen 15.5.2014
Tutkinto	Muotoilija AMK
Koulutusohjelma	Muotoilun koulutusohjelma
Suuntautumisvaihtoehto	Teollinen muotoilu
Ohjaaja(t)	Tuomo Äijälä, Lehtori Pasi Paananen, Teollinen muotoilija

Työn ensisijaisena tavoitteena oli luoda käyttäjän autoon yhdistävä auton sisäinen informaatio- ja viihdejärjestelmä. Kohdeautona toimi Biofore -konseptiauto, Tekes-hankkeen yhteisprojektina kehitetty teknologiademonstraatio. Toissijaisena tavoitteena oli luoda auton informaatio- ja viihdejärjestelmään vihreä elementti.

Tämä on toiminnallinen opinnäytetyö, jossa kerrotaan projektin vaiheista ja avataan prosessin kulkua. Työssä näkyy vahvasti tehty suunnittelutyö ja sen aikana tehdyt opastavaan ja vertaavaan aineistoon tukeutuvat päätökset.

Projektin lopputuloksena oli vuoden 2014 Geneven automessuilla esitellyssä konseptiautossa ollut graafinen käyttöliittymä ja siihen kehityt ominaisuudet. Ominaisuuksiin kuului muun muassa “Biofore” älypuhelinsovellus, “Vihreyspeli” ja navigaatio-ominaisuus.

“Biofore” älypuhelinsovelluksella pystyi esimerkiksi vaihtamaan auton mittaristoja ja muuttamaan sisustan valaistusta. “Vihreyspelin” tarkoituksena oli opastaa auton käyttäjiä taloudellisempaan ajamiseen. Sen ominaisuuksiin kuului muun muassa ajetun matkan analysoiva ohjelma, joka näytti ajon jälkeen matkan karttakuvana, josta pystyi näkemään ajokäyttäytymistään. Tiukan aikataulun takia “Vihreyspeliä” ei kehitetty yhdeksi lopullisista autossa olevista ominaisuuksista.

Työn aineistotutkimuksen yhteydessä luotiin graafisten käyttöliittymien suunnitteluohjeisto. Suunnitteluohjeiston paikkansapitävyyttä ei kyetty projektin aikataulun takia testaamaan, mutta suunnitteluohjeiston sisältö perustuu luotettaviin lähteisiin.

Avainsanat	UI, GUI, UX, IVI, Älypuhelin

Table of contents

Keywords & Key concepts

UI:	User Interface	GUI:	Graphic User Interface
UX:	User Experience	AC:	Air Conditioning
HDD:	Hard disk drive		

HUD: Heads-Up-Display, a display that is usually placed in front, or on a car's wind shield. The purpose of the HUD is to display task vital information.

IVI: In-Vehicle-Infotainment, a system that combines Information and entertainment elements in a car's user interface.

LHD/RHD: Left Hand Drive, Right Hand Drive, The side of the car from which the car is driven.

MAW: Main Activity Window, fixed placement for the most important menus, and controls for the AC and the media player in the IVI system.

RGB: Red-Green-Blue, most screens use a combination of RGB LED's to create a picture.

SSN: Separately sold in-vehicle navigator.

Widget: "In computer programming, a widget (or control) is an element of a graphical user interface (GUI) that displays an information arrangement changeable by the user, such as a window or a text box." (Wikipedia, 2014).

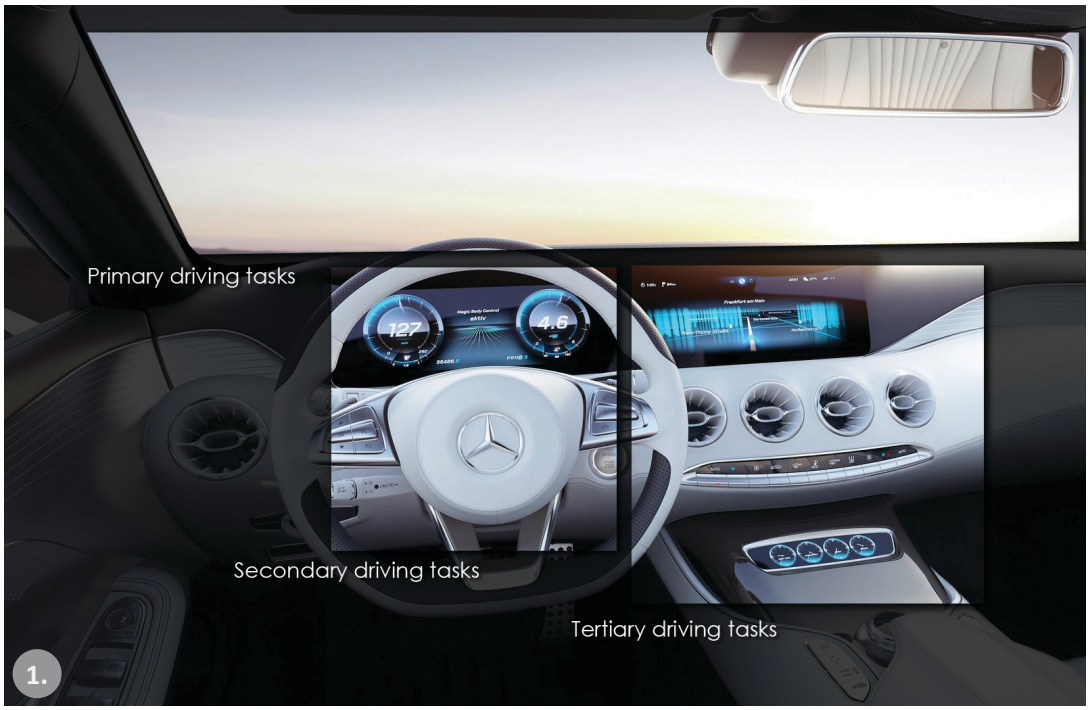
Driving task areas: The separation of driving task areas into three categories based on their importance. See picture 2.

HMI -model: Human Machine Interface. See picture 1. for further explanation.

Digital input elements: All buttons that have functions in the IVI. For example: air conditioning controls, radio controls, interior lighting controls, etc.

Digital output elements: All graphic and voice information that is being targeted from the IVI to the users. For example: a light accompanied by a ticking noise indicating that the blinkers are on or a graphic display of the car's current speed.

Driving task areas (Dagmar Kern, Albrecht Schmidt, 2014)



1 Introduction

1.1 Background

1.2 Aim of the thesis

1.3 Starting point

1.4 Theoretical framework

1.1 Background

In 2010 the UPM-Kymmene Corporation contacted Metropolia, Helsinki University of Applied Sciences. The UPM-Kymmene Corporation had new bio-based materials for which they were looking for applications and routes in the automotive industry and other suitable research areas.

Metropolia, Helsinki University of Applied Sciences gathered a group of Finnish companies and universities with the same objectives. From this was born a Tekes- technology and research project. As a part of that project a car was built as a technology demonstration platform.

From the year 2010 until March 2014, Metropolia has been designing and building a concept car to be used in highly urbanized areas that follows the principles of sustainable development.

I have had various duties in the mentioned project; acoustic design, camera application design and so on. My main task, starting from the summer of 2013, was designing a graphical user interface (GUI) for the Biofore concept car. The concept car is to be made road legal by the end of year 2014.

My basis included a designed car that was under construction during the process phase of the thesis, which meant that I had to base some of my work on design sketches, 3D models, and regarding them the assistance of Juha Tuomola, an industrial designer who had been in the project from the beginning.

The concept car was first unveiled at the 2014 Geneva motor show.

My work with the user interface design was sponsored by the Finnish Cultural Foundations, Juhani Korpivaara's Toyota Foundation.

2.

Picture of the concept car. (UPM, 2014)

1.2 Aim of the thesis

The aim of this thesis was to create an IVI system that really connected the driver to his or her car. The IVI also had to have a green element, as one of the core design principles for the Biofore concept car was that, it should become a forerunner for manufacturing road capable vehicles out of more biodegradable and reuseable materials. Since the car itself was a technology demonstration platform this was good chance to create something that had not been done before.

During the project more functions were made than are shown in this thesis. Among them were: Side mirror angle controls, parking assistance controls and ride height controls, etc. They were not necessary to include in the thesis because they hardly helped to connect the user to his or her car.

Picture of the concept car's interior. (UPM, 2014)

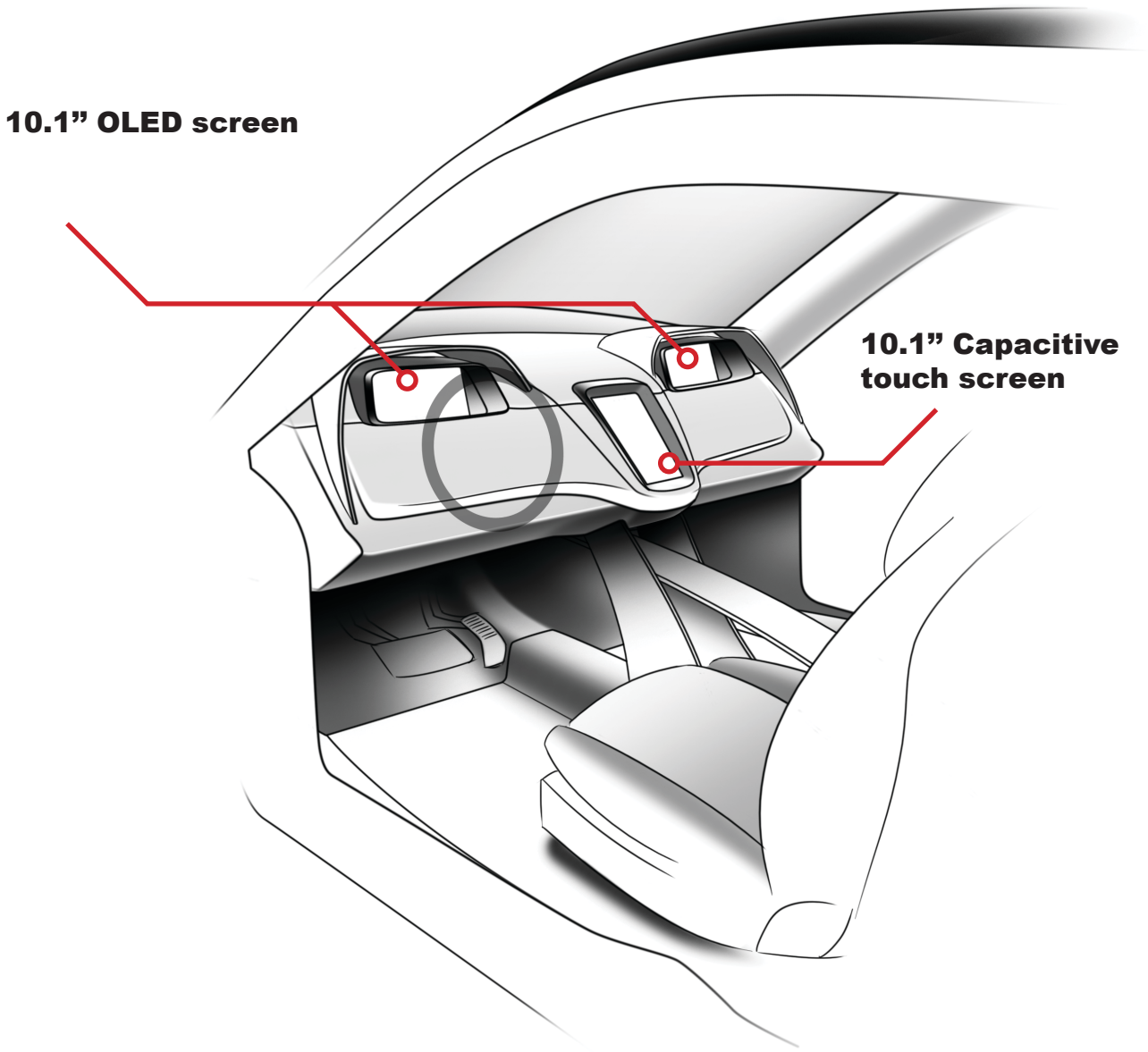
1.3 Starting point

The interior of the concept car had already been designed and that of course defined what kind of actual space and what type of technology I was working with.

The Biofore concept car had three screens in it's interior, one of which is a capacitive touch screen. (See image 4.)

Everything that was to be displayed on those screens would be processed by a fleet-pc and a pack of Raspberry Pi's that would communicate and transfer data through an internal wifi network.

Ubuntu, a variation of the Linux computer UI was selected as the platform for the programming code.



A sketch of the concept car’s interior showing the three screens.

1.4 Theoretical framework

User exprience is one of my key concepts. How the users perceive graphical user interfaces in cars. What kind of feelings do they have when they turn up the volume when a good song is playing. Cognitive ergonomics are also important in what I need to design. When a user enters the car what kind of an interface would make him or her realize that the middle screen is something they can touch. The users remember devices that they have used before, how could I build something that relies on their already existing knowledge.

How could I effect what the users experience while driving the car. How could I truly make the user feel connected to his or her car. Could I connect their family or friends to the car they drive as well? Maybe the users would like to transfer data from their home computers to their car.

Through what kind of interface? What does it look like, do the buttons make the users think that: “When I press this part of the screen I will go to a new menu.” Graphical user interface design is also one of my most centered subjects. Why would you have to read when you can see from the icons and buttons that this is the way to go.

I believe sensory ergonomics are studied when designing a car. The exterior shell is what we experience first when approaching a stationary vehicle, but motor vehicles are a lot more than what we see. When one listens to the sounds car doors make when they are shut they can be very different from each other. The sounds can either be hard machine like sounds of metal hitting metal or a soft “thump” or something completely else. That sound makes the users feel something and in some cars I am sure that sound was designed to be what it is. Certain sounds can make people feel trust, fear, joy, excitement and so on.

Driving a car be a pleasant experience, but it becomes very unpleasant extremely fast if you forget to put your seatbelt on in a newer car. The sound that a car’s IVI is meant to play on repeat when one is driving around without a seatbelt is, to put it bluntly annoying. I believe annoying is what it was designed to be, so that we would not drive without a seatbelt. The same applies to the sound one hears when a car is trying to signal that it is running out of fuel or oil.

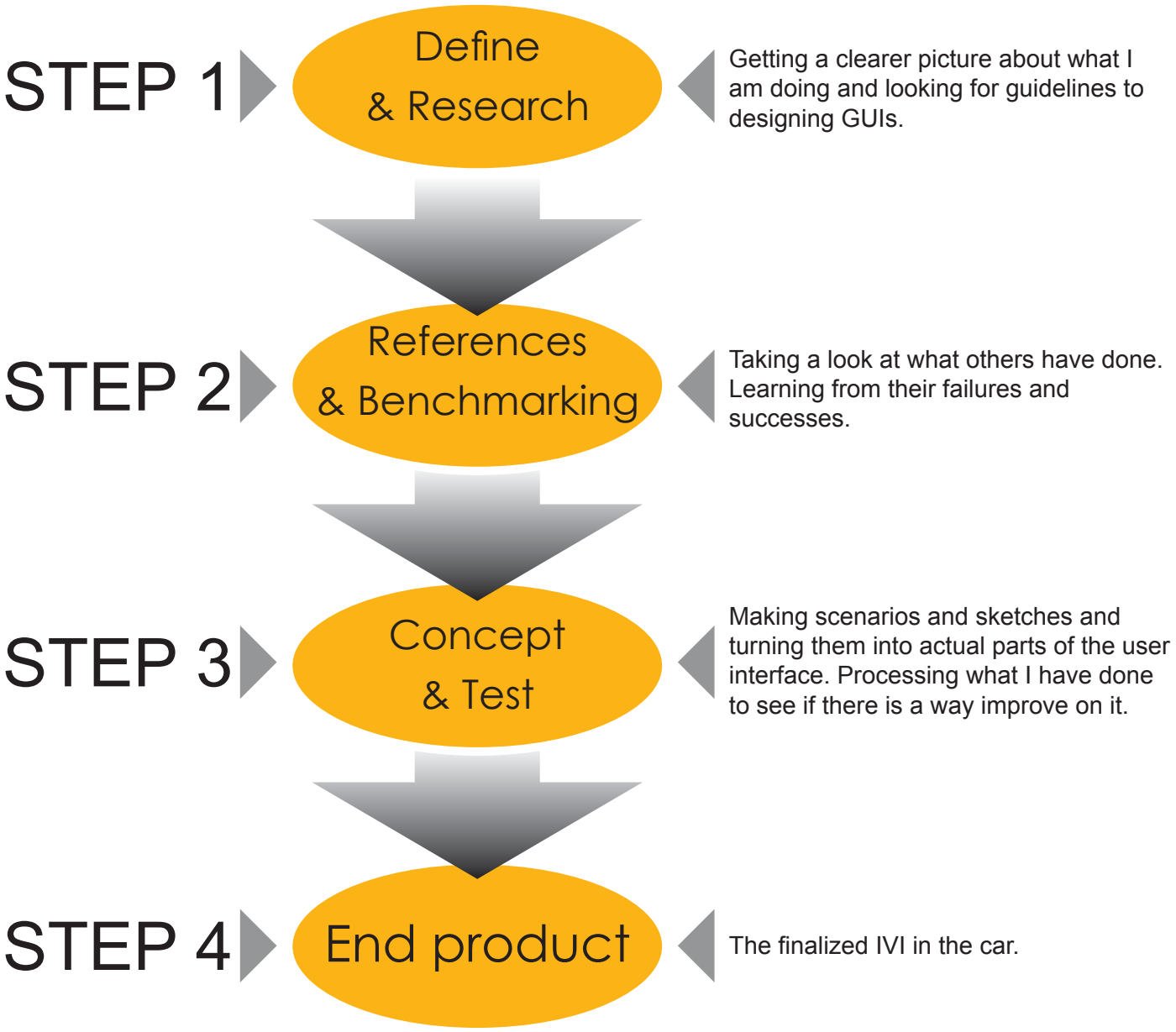
More theoretical framework can be found in chapter 2.1 Define & Research.

5.

2 Process

2. Process

Design process



2 Process

2.1 Define & Research

2.1.1 Basic questions

WHAT? I am designing a graphical user interface for the biofore concept car. Trying to find new ways of displaying data necessary to the driver. Aiming to create something different, that would better connect the users to their cars.

WHO? The actual target audience was never selected, but the project group had agreed on the users being young adults, from 20-40 years of age who live in the city. They probably have children and are very environmentally concious, but need the car to go shopping and to take themselves, their kids and relatives around.

HOW? While researching UPM I found out that one of their values was “Renew with courage.” (UPM, 2014). The explanation of the value didn’t quite fit into what I was doing but the value itself did.

2.1.2 IVI requirements

Before I could start I needed to know what kind of functions the IVI would have within it.
Together with the project team we brainstormed and decided that the IVI should have atleast the following:

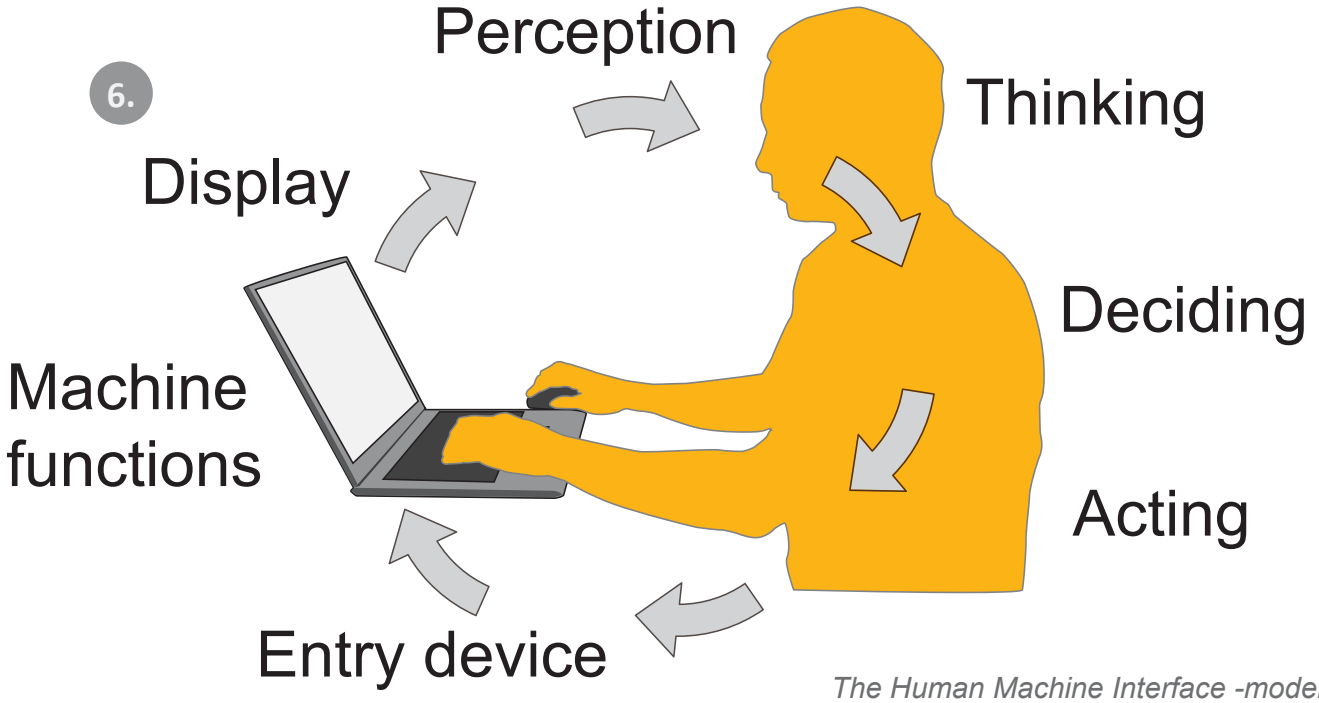
-Rearview mirror image in the IVI,
-Side mirror angle controls,
-Parking assistance contols,
-The dial console with warning- and signal icons,
-Ride height controls,
-Interior lighting controls,
-Air conditioning controls,
-Audio player,
-Web-browser,
-Navigation (if possible),
-possibility to have other applications.

2.1.3 Guidelines for GUI design

The list of functions and basic questions guided me to look for manuals on how to design automotive GUIs; What the GUI needed to have, what I should avoid and what I should take into consideration.
An automotive GUI, much like any other GUI could be well pictured using the Human Machine Interface -model. (HMI) See picture 6. below.

The HMI model shown consists of a laptop computer that contains input- and output devices and a person using it, together they form a human to machine user interface, through which information should fluently travel back and forth. “The HMI model has been critized because it sees the human as a part of the machine. The only way the HMI can work is if the human part works according to plan, without a flaw.” (Launis, 2011, 224.) Unfortunately being flawless in one’s actions is not always possible. People get tired and distracted, while driving a car those things can cause mistakes that lead to collisions or other traffic violations.

6.



The Human Machine Interface -model. (Launis, 2011, 225)

“To help avoid human errors it is possible to attach different types of technical assurance devices to the system.” (Launis, 2011, 225). These assurance devices have been in cars for some decades now. There are systems that directly interfere with your driving. For example, while braking the ABS -system makes sure that the car’s brake discs do not lock, ensuring that you still have steering control and that you get the best possible braking power. Then there are systems that inform you of possibly dangerous situations by using a warning sign. For example when your car’s engine is running out of oil. Last but not least there are systems that aid the driver, systems like the Mercedes Benz “Attention assist” (Daimler, 2014). The “Attention assist” system looks for signs of drowsiness in the driver by monitoring his way of driving and then comparing that to other relevant factors, such as the lenght of the trip and the road surface. (Mercedes Benz, 2014).

7.

8.

“A UI needs to fit in with the way it’s users think and it has to correspond their level of data processing.” (Launis, 2011, 226). People who drive newer cars have gotten used to quite a wide variety of automotive user interfaces. Especially during recent years as touch screen devices have made their way into cars, as shown in images 9,10 and 11. “The way information that is shown has to conform with the way the device is operated and with what the users expect. Differing systems may cause unnecessary stress and operating faults.” (Launis, 2011, 228.) Two very good ground rules to keep in mind, as if one would design a touch screen tablet- like UI and apply that to a non- touch screen device the user experience (UX) could suffer. A similar situation can be seen in some Windows 8 operated computers. (See picture 16.)

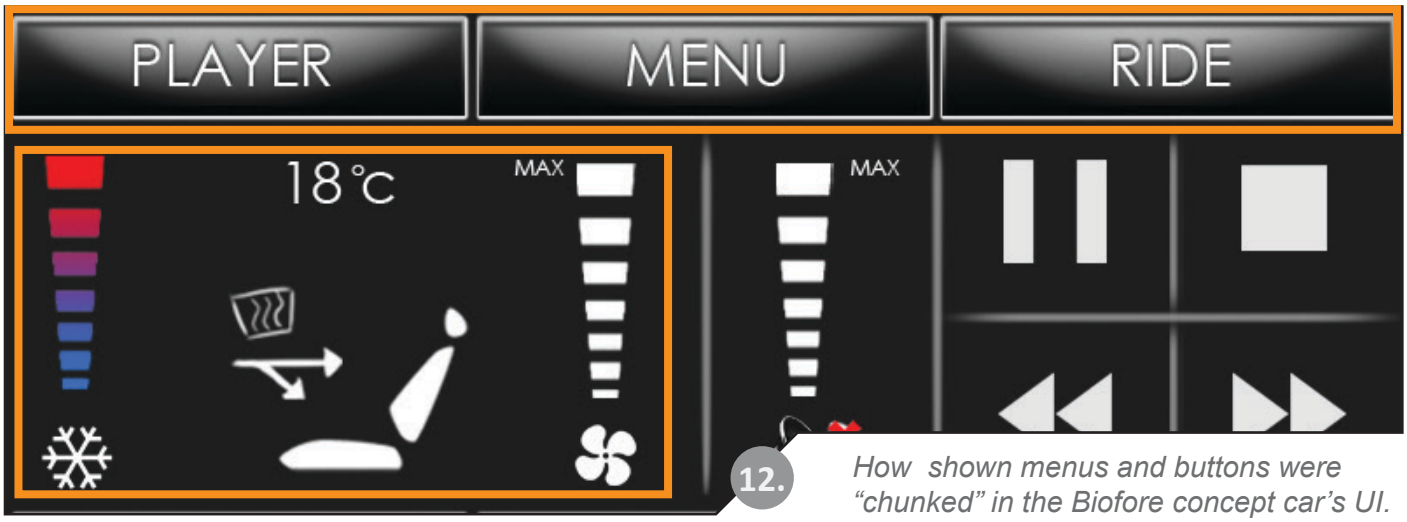
> When designing the operating situation, one has to take in to consideration the exterior factors that affect it, for example the effect surroundings and other functioning humans or machines have on the tasks as a whole. (Launis, 2011, 226.)

-A very important phrase as I suspect when automotive UI’s are being designed, the designer most likely thinks about the effect that other drivers and nature have on the driving task. As depicted by Dagmar Kern and Albrecht Schmidt (2014.) in distinguishing of the driving task areas, the most important job that the driver has is knowing what is going on outside the car. Everything else is either of secondary or tertiary importance. (Kern, Schmidt, 2014). In the Biofore concept car, this includes the user interface seen from the three screens. (see picture 4.)

Though when driving, usually the driver does not have to apply all of his or her concentration on the road, he or she has a chance to do other things as well. Things like adjusting the air conditioning, controlling the speaker volume or switching the radio station. This is of course dependent on the traffic situation, but because of it, the driver is limited to only receive a certain amount of information. In the EN ISO 15005 standard about the *“Ergonomic aspects of transport information and control systems - Dialogue management principles and compliance procedures”* (2002, 7). it is mentioned that a “transport information and

control system” (TICS) dialogue with the driver is successful when it “has fulfilled timing and priority requirements for driving when continuous driver attention to traffic situations is supported, or not adversely influenced.” (EN ISO 15005, 2002, 7).

The amount of information seen in the GUI should be limited and grouped or “chunked” (Extron, 2014, 5, 30) to tidy packages. This helps the user see and understand the relevant information. Chunking information in the input elements, like buttons, can expedite the usage of functions. (See picture 11.) The information should also be shown so that it pops up from the background. Strong contrasts, appropriate



How shown menus and buttons were “chunked” in the Biofore concept car’s UI.

sizing and assistive sound feedback can help make this possible. (Launis, 2011, 227.) In cars the faster you find what you are looking for, the faster you can concentrate fully on the primary task of driving. I believe that an easy to use GUI in a car also makes the UX while driving much more rewarding. “Touchpanel user interfaces must be designed using consistent, logical, and predictable layouts.” (Extron, 2014, 6). To help create consistent and logical GUIs the use of dynamic and static interface areas can be used. A static area consists of buttons and other GUI elements that never change place. The static area is usually an optimal place for controls that are being used and or needed often. (Extron, 2014, 7.) “Dynamic areas are reserved for content that varies based on the mode of the control or the conditions of the selected operation.” (Extron, 2014, 8). A very good example of the use of dynamic areas can be seen in smartphones. The area that is normally reserved for the desktop-like space that contains widgets and application icons turns into an application view once an application is opened. The basic controls still remain in their given place. (See images 13-15.)

Dynamic and static areas in a Motorola Razr smartphone.

Well placed input- and output elements help you find what you are looking for faster, but only if their graphical appearance, size and shape in the screen allows it. (Extron, 2014, 12). Choosing a color palette to work with is extremely important. (Extron, 2014, 13, 20). Not only to help create an aesthetically pleasing GUI to the eye, but also to make sure that the colors make the important information well noticeable. Mixing warm and cold colors that are of the same tone create a pleasing image. For most

Windows 8 UI in a desktop pc.

Windows 8 UI converted to grayscale.

people that mixture would work just fine, but what if the person using the GUI has deficient color sight or they are completely color blind? Monochrome testing in grayscale (see picture 17) should be done to confirm that a designed GUI is also visible to those who have impaired color sight. (Extron, 2014, 22.)

The typography in the UI should be well perceivable and the language used has to be familiar to the users. “The signs and icons have to be unambiguos to prevent interpretation errors.” (Launis, 2011, 227). In motor vehicles the warning signs and other not so important signals, like blinker lights and the icon for cruise control are usually very similar to the ones found in other vehicles and there is a reason for that. *The EN ISO standard 15005* (2002, 6). states in the “Recommendations” that; “Since it is assumed that even a

Warning signs in motor vehicles.

naive user of the TICS will have knowledge of vehicle operation, dialogue for information systems will use familiar icons, symbols and text found in other vehicles." (EN ISO 15005, 2002, 6).

"Buttons are the primary means of interaction between the user and the touchscreen." (Extron, 2014, 24.) It would be hard for the user to navigate in GUI if he or she can not understand what graphical elements are buttons. For this reason buttons should look like they can be pressed. This gives the user an image of "affordance." Affordance in a GUI basically means that a user is given a visual of all the things he or she can do. False affordance on the other hand visually informs the user that certain buttons should not be used, or that they are unavailable at the time. (Extron, 2014, 3, 4.)

19.

A button that can be pressed.

20.

A button with false affordance.

> The recognition of signals that require immediate attention like the warnings signs or the blinker in cars, have to be made easier detect, for example by using at least two sensory stimuli, like bright colors and sounds that stand out. (Launis, 2011, 227.)

Using this priciple people will most likely notice that something is wrong with a vehicle. Okay good, but what if the warning sign itself is inadequate? In picture 18. most of the warning- and informing signs used in vehicles can be seen. To someone who does not know what individual components in vehicles look like, the list shown could have many icons that cause confusion. For this very reason information that could be harmful to either the driver or the car should be given in writing and it should be available until it is seen and accepted by the driver through a button. (Launis, 2011, 227, 228).

In the HMI -model the human part is the weak link, therefore it's limitations have to be taken into consideration. Humans in general are good at perceiving familiar signals and information that are being targeted to them, but as the amount of signals and information increases so does the load to the human brain. Therefore the way data is shown, the amount and the timing have to be in line with the requirements of the operating situation. Receiving information can also be made easier by limiting the number of tasks that require precision and by removing all sudden high volume noises and innecessary alarms, because they can cause discomfort and stress. (Launis, 2011, 226, 227.)

Learning to use a new type of interface requires a lot from the user.

> In order to keep the learning process as easy, fluent and errorless as possible, different parts of the UI should function the same way. Once a user has learned to use one part they will also know how to use the other parts. (Launis, 2011, 230.)

Even with fairly simple new interfaces the learning process might still have it's problems. For example people from different backgrounds and cultures usually see things in a way others do not. To make the learning of more demanding parts in a UI easier, one should include simple guiding messages to aid the user and the content of those messages should be unambiguous and relatively short. (Launis, 2011, 231).

2.1.4 Conclusions

From the processed guideline information I put together a list of ten important guidelines.
They would help create a functional and safe GUI to be used in a motor vehicle.

1. **Make sure the GUI is self-explanatory and consistent with shown information. All functions should operate in the same way to ease learning and use.**

2. **Use static and dynamic areas in the GUI.**
They can help the user locate wanted functions.

3. **Use easy to understand fonts, icons and signals.**
Apply clarifying text to otherwise unclear icons.

4. **Signals and warnings that require immediate attention should be given in atleast two forms of sensory stimuli.** For example in visual and vocal information.

5. **Avoid unnecessary alarms, other high volume noises and suprising flashing lights.**
They may cause unwanted stress in the driver.

6. **Use warning signs and icons that are also used in other motor vehicles to make sure that a driver understands their meaning.**

7. **Functions and data that could be relatively hard to grasp need help messages.**
Keep those messages simple and short, and available until the user has seen them.

8. **Use color and contrast to aid the driver to locate the important things.**
Before applying the GUI to an actual device, monochrome test in grayscale. It will show you if some parts are invisible to users who have imparied color sight.

9. **Limit the number of tasks that require precision while driving.**
For example, disabling the keyboard in a touch screen used GUI while driving is a valid option to ensure driver safety.

10. **Keep dwell times in a minimum. The driver should never have to concentrate on a secondary or tertiary driving task for more than 1.5 seconds at a time.**

2 Process

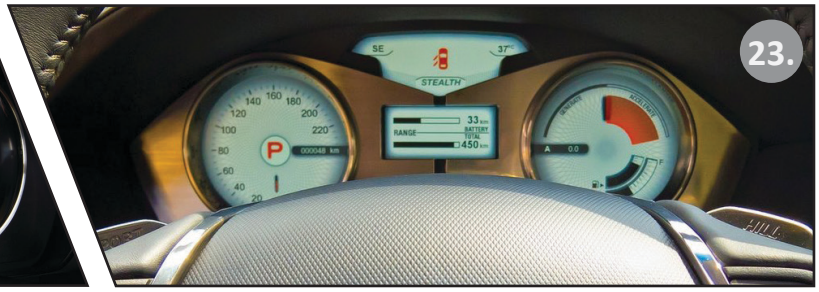
2.1 Define & Research

2.2 References & Benchmarking

2.3 Concept & Test

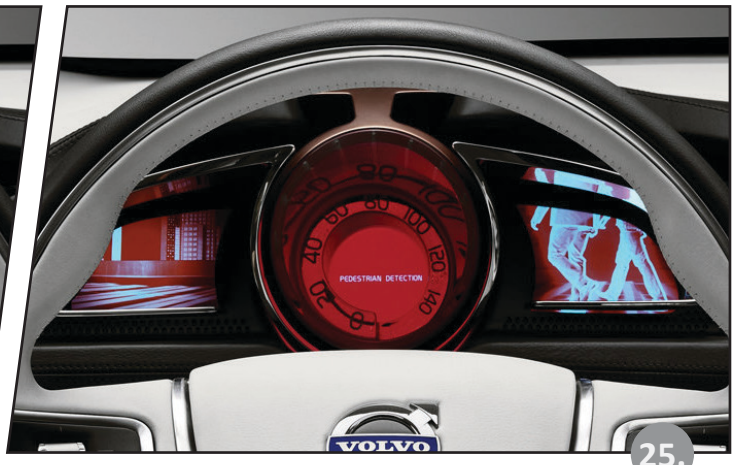
2.2 References & Benchmarking

Fisker
Karma
2011



One of the things I liked very much in IVI systems of both the Karma and the S60 Concept were the dials. With the Karma the colors of the dials changed with the drive mode of the car.

In the S60 Concept the entire dial console including the information screens on both sides of the speedometer dial change as the car notices a dangerous situation. Volvo S60 Concept uses the information screens to show what the car noticed and changes the color of the speedometer dial to increase the chance of detection.



Volvo
S60 Concept
2009

Above on the left, the GUI in the Mercedes Benz A-class concept resembled a touch screen tablet-like UI very much. I think that was a good decision as the device itself resembles a touch screen tablet. Most likely a user who sees the device for the first time would right away have an idea of how to use it. Above on the right you can see the GUI from an A-class production model. The tablet- like application icon line up was dismissed for a more hard data type of approach with written menus. The GUI consists of two static areas, one in the upper part of the screen and the other in the lower part. The middle part is a dynamic area that changes when you open a menu or use a function. Much like the GUI from an Acer Iconia A1 -android tablet shown below.

Acer Iconia A1 -android tablet.

30. *The GUI middle screen view from a Tesla Model S.*

Tesla
Model S
2013

In the previous page the GUI middle screen in the Tesla Model S' center stack has by my opinion one of the best uses of space in automotive GUIs to date. Of course it is easy to fit in a lot of things and still keep the UI spacious when the screen is 17 inches in size. Ignoring the size, visually the GUI pleases my eye very much.

It has two static areas as the tablet -like UI in the Mercedes Benz A-class and the actual tablet UI from the Acer Iconia. In the lower part of the screen you can find the air conditioning controls, seat warmers, glass warmers and ride controls. In the upper part there is a very android tablet -like information bar that houses a date and time view and other device important data. Right below it there is a space reserved for the other functions. The area in the middle with the two "windows" is the dynamic space. The space can be filled with small windows from various applications. It can also be turned into one massive window for one application like the one seen in picture 31. above.

Tesla Model S.

33.

Volkswagen
Bulli Concept
2011

Large touch screens in your tertiary driving task area are a very good thing in the sense that their large size helps blind use. This means less time is consumed by looking right and down (in a LHD car) to see what is actually going on. To further aid blind usage of instruments in the tertiary task area, haptic feedback could be added. However when you are in a moving vehicle you rarely have the luxury of being in a completely vibration free zone. To help avoid misunderstood signals, voice feedback, like the one you get when you use the blinker, might be a better solution in a car.

In the Toyota FCV-R-concept the actual touch screen in the center stack is not that big, but then again it does not have to be. The speedometer, a small player and the map view have been relocated in to a heads-up-display (HUD) that is right below the windshield of the car. Less reaction time is needed to comprehend where I am going or at what speeds. Also changing the song or the radio channel would be a lot easier, assuming that you have an idea of what the player menu looks like in the center console. Once you have changed the channel you would immediately get a visual feedback in the HUD. It requires less dwell time in the screens to find the radio channel you are looking for.

Toyota
FCV-R-concept
2013

34.

Volvo On Call

35.

A screenshot from Volvocars.com -website.

Volvo was the first company to release a mobile application that connects the driver to his or her car, even when they are nowhere near it. (Jaynes, 2013).

> The Volvo On Call app lets lets you lock your car, find your car, view your dash board and set your heater at the touch of a button. You can also get an overview of all your journeys using the Driving Journal, which you can export as a spread-sheet. Do you have the Sensus Navigation option? Then you can use the app to send a destination to your car and start driving right away. The Volvo On Call app is available for all Volvos from model year 2012. (Volvo cars, 2014).

After Volvo released the “On Call” -application other major car manufacturers have been developing their own smartphone applications with similar properties. Qoros has the “Qloud.” An application that offers everything from car care services to parking tips. BMW has the “Concord”, Toyota has “Entune” and so on. In the world of today where everyone is always busy, an application like this really has a place in the market. I believe that a scenario, where a person leaves their car and after a while has no idea if they had locked the doors or not, is not that uncommon. With the “On Call” -application they could easily check the status of their car without actually going to it. That is brilliant.

The Volvo On Call application in smartphones.

36.

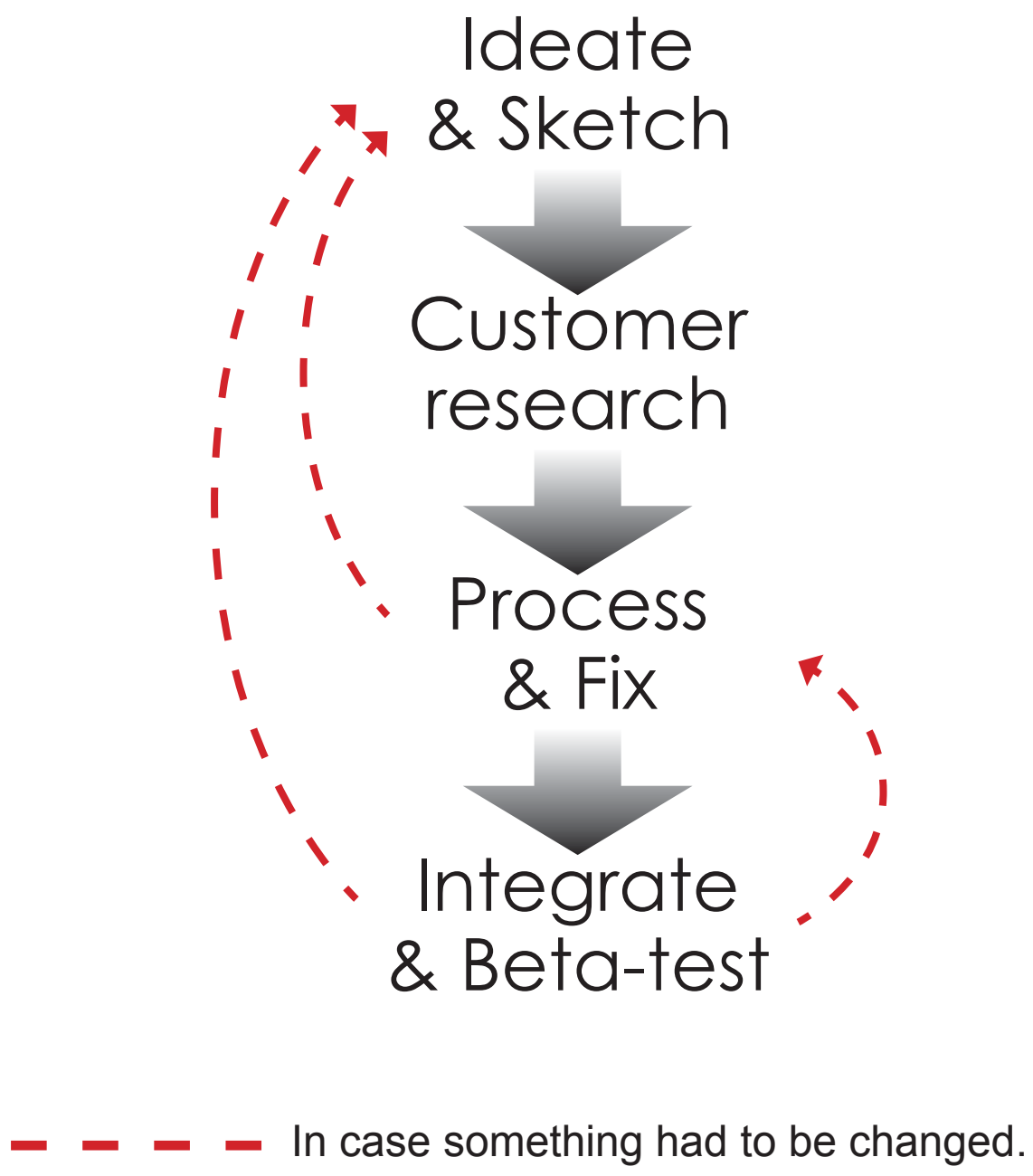
2 Process

2.3 Concept & Test

I wanted to have the freedom to think outside the car. This is why I first sketched and made digital models of some of the functions the car would have.

This way if I found something great I could use the sketches to ask the probable users to give their opinion.

After processing what the probable users had answered, it would become a lot easier for me to see what ideas were good and how I could make them even better.



2 Process

2.3.1 Ideate & Sketch, Pt. 1

The list of functions amassed in chapter 2.1. “Define & Research” acted as my basis. They were the things the IVI needed to have.

The view I had gathered from the reference material in chapter 2.2 “References & Benchmarking” and the list of guidelines I had put together in chapter 2.1.4. “Conclusions” were my How-to-design guides.

I liked the GUIs in smartphones and android tablets, they were easily customized to the users needs. They were also from my point of view, relatively simple to use, even for someone who had never seen one before.

I loved the changing dials in Fisker Karma and Volvo S60 Concept, they were so science fiction, but yet something that should have been made a long time ago. To help connect the driver even more to his or her car I had to design something like that.

So the IVI needed to be something like the things mentioned. I had to keep in mind though, that if I made the GUI too calling, it might end up distracting the driver from his or her main task of driving.

2.1 Define & Research

2.2 References & Benchmarking

2.3 Concept & Test

2.3.1 Ideate & Sketch, Pt. 1

Desktop & Functions

Menu logic

Interior lights & Dial controls

Dials & Rear-view mirror

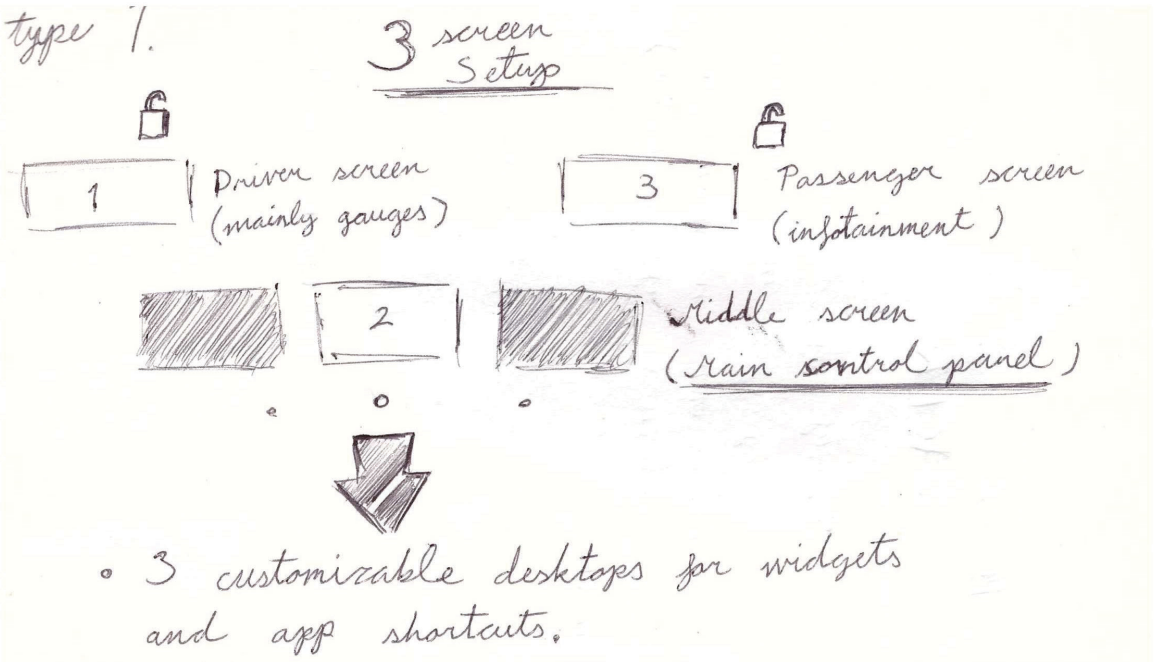
2.3.2 Customer research

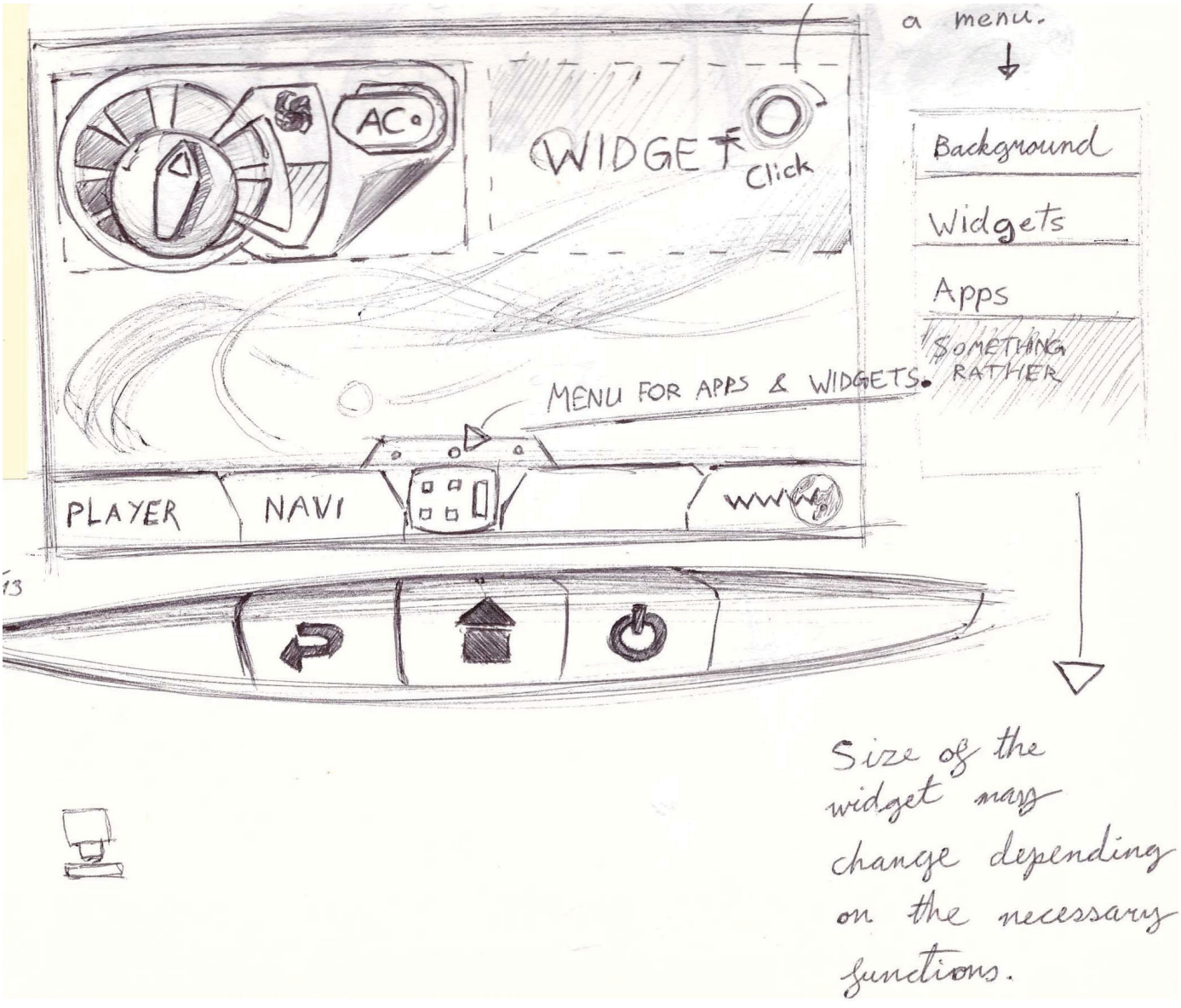
2.3.3 Process & Fix

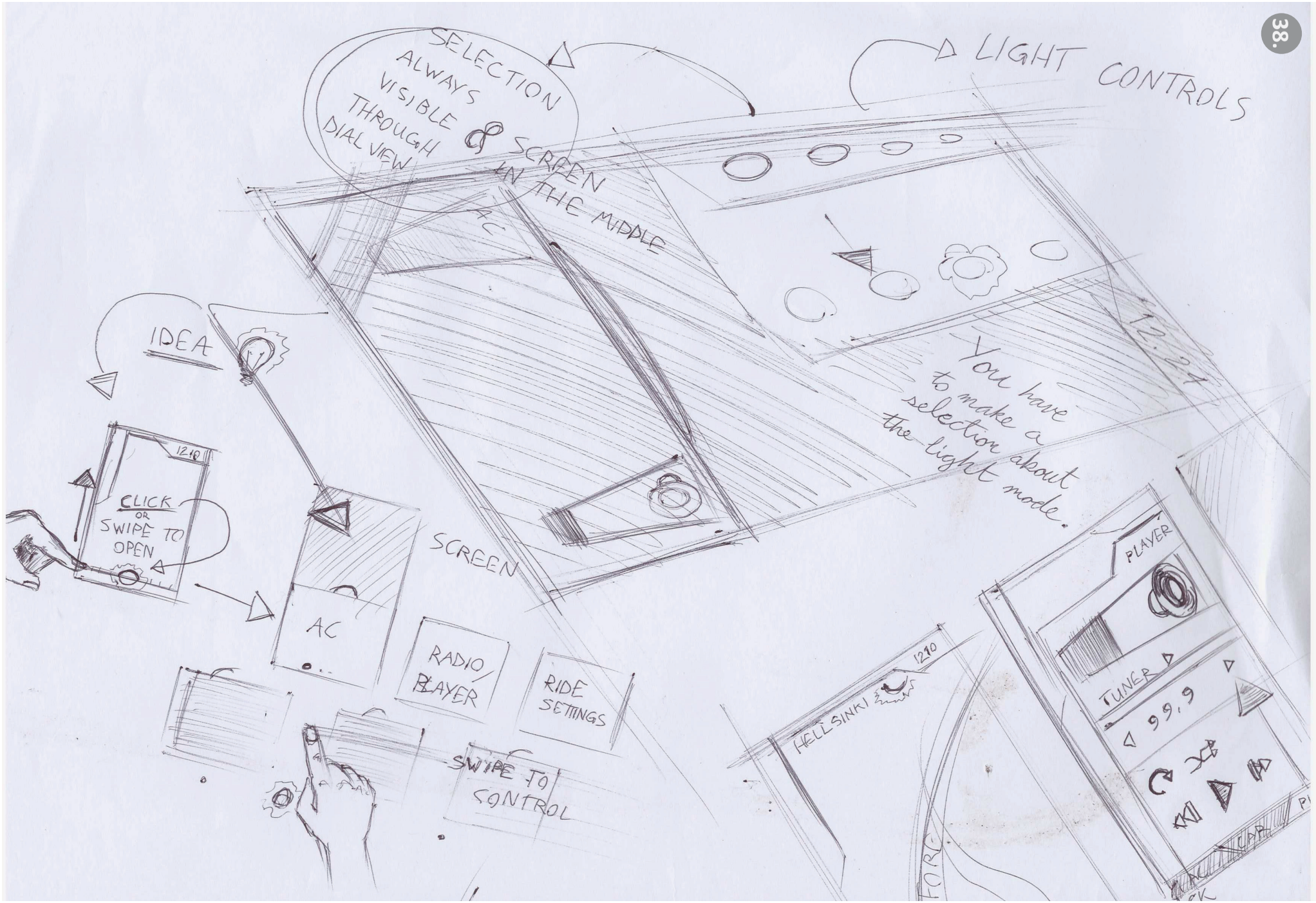
2.3.4 Ideate & Sketch, Pt. 2

Sketches of the Desktop & Menu structure

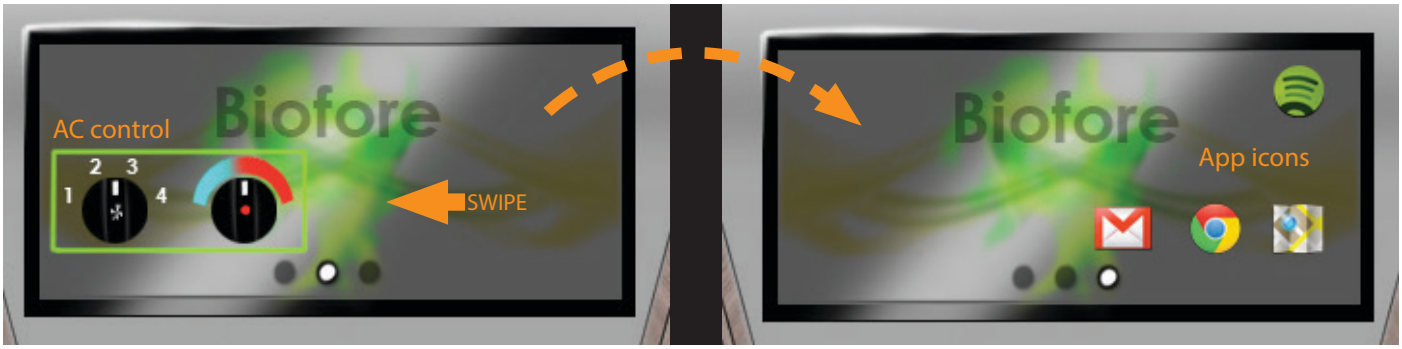
37.






38.
SELECTION ALWAYS VISIBLE THROUGH DIAL VIEW
SCREEN IN THE MIDDLE
LIGHT CONTROLS
AC
IDEA
12.27
You have to make a selection about the light mode.
1210
CLICK OR SWIPE TO OPEN
SCREEN
AC
RADIO/ PLAYER
RIDE SETTINGS
SWIPE TO CONTROL
HELLSINKI
1210
PLAYER
TUNER
99,9

I had an idea of the GUI's desktop being similar to that of an android smartphone's. That meant having multiple desktop "surfaces" which you could navigate through by swiping left or right. The user could use these "surfaces" to store their favourite apps and widgets. Widgets like the AC control shown in picture 39. With a desktop like the one shown, the users could customize the dynamic area of their car's IVI system to fit their needs. The only problem with a very tablet -like UI was that there were no fixed controls for anything. That would most likely have caused frustration in first time users unless I made quick help windows to aid them.

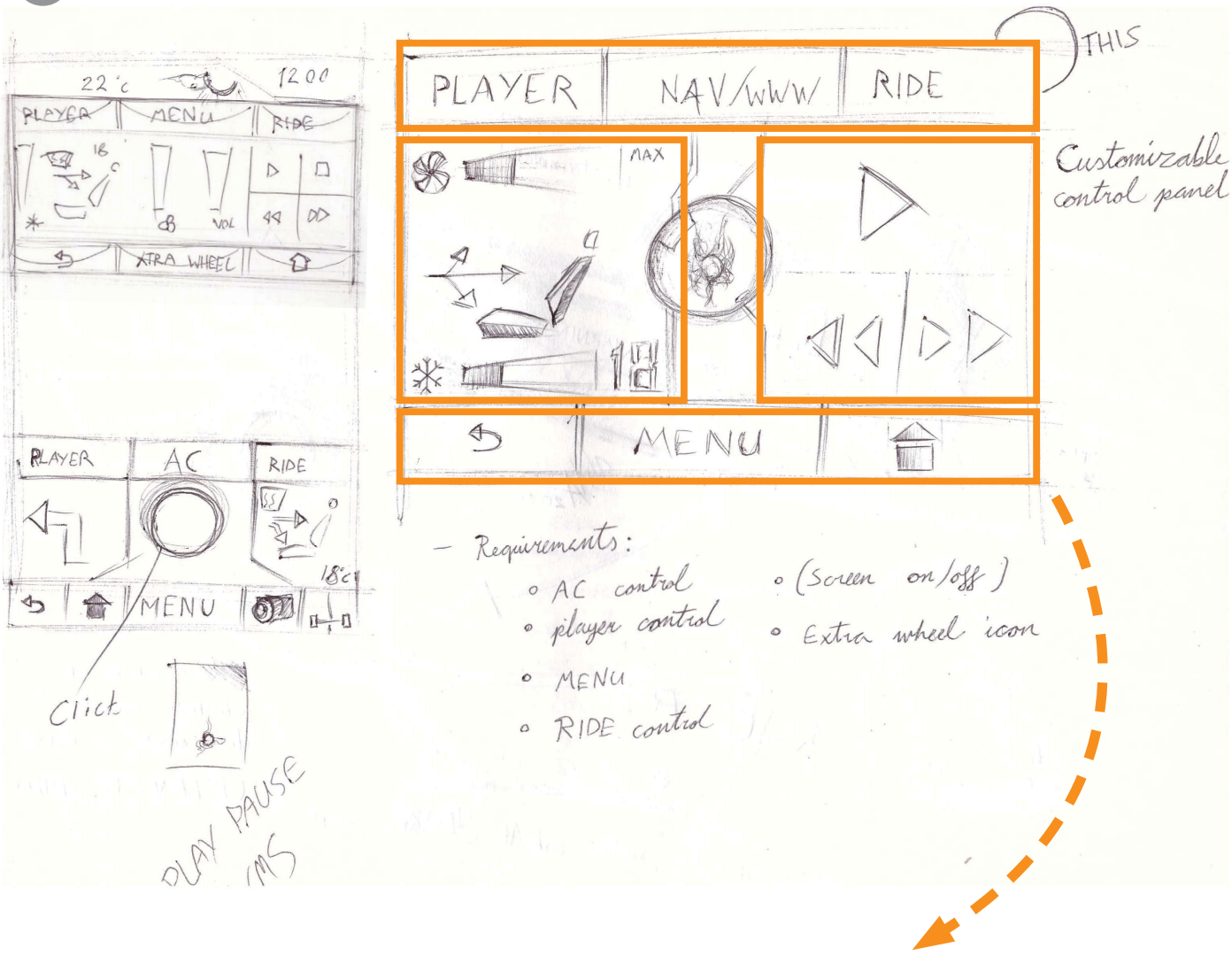


A digital image of how the desktop would work. 39.

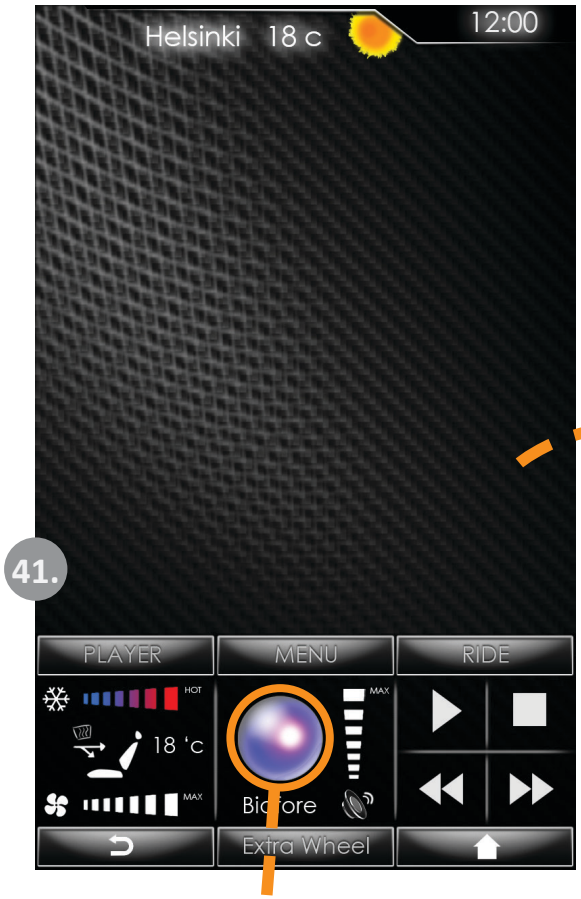
I still felt that this way of customizing everything would have been way too hard to quickly explain, especially as the GUI was to be used in a car. While searching for references I found that most cars follow a pattern in the way their UIs are designed. Screen or not, I saw that the AC and player controls were always visible in the center console. This same positioning of elements was also repeated with almost all other driving task instruments, like; driving lights, dials, warning signs and so on. I moved on to sketching a layout with fixed basic controls for the IVI.

Sketches of the fixed controls.

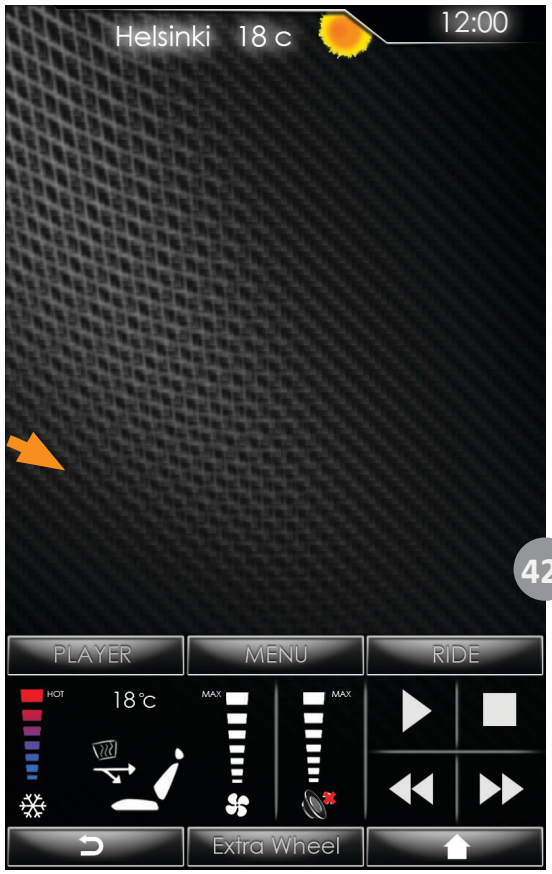
40.



I went back to my guidelines and found that “chunking” buttons was the way to proceed. Chunking also made it possible to easily display the probably most used functions in the IVI. I began thinking more about what the user would actually need. I found a basis for that information from the list of functions the IVI should have.



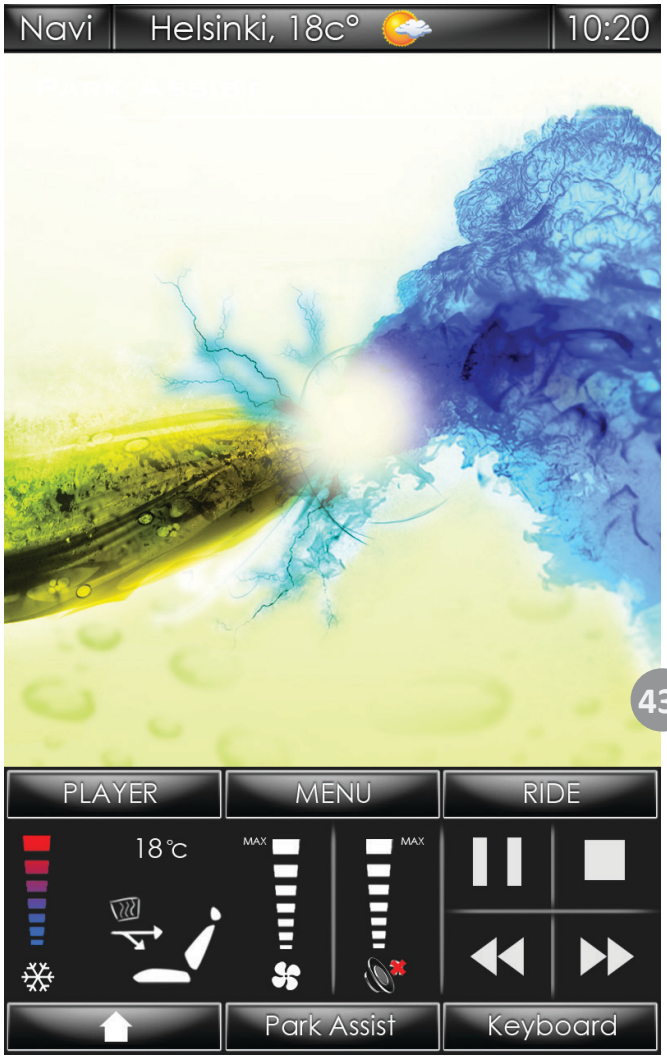
41.



42.

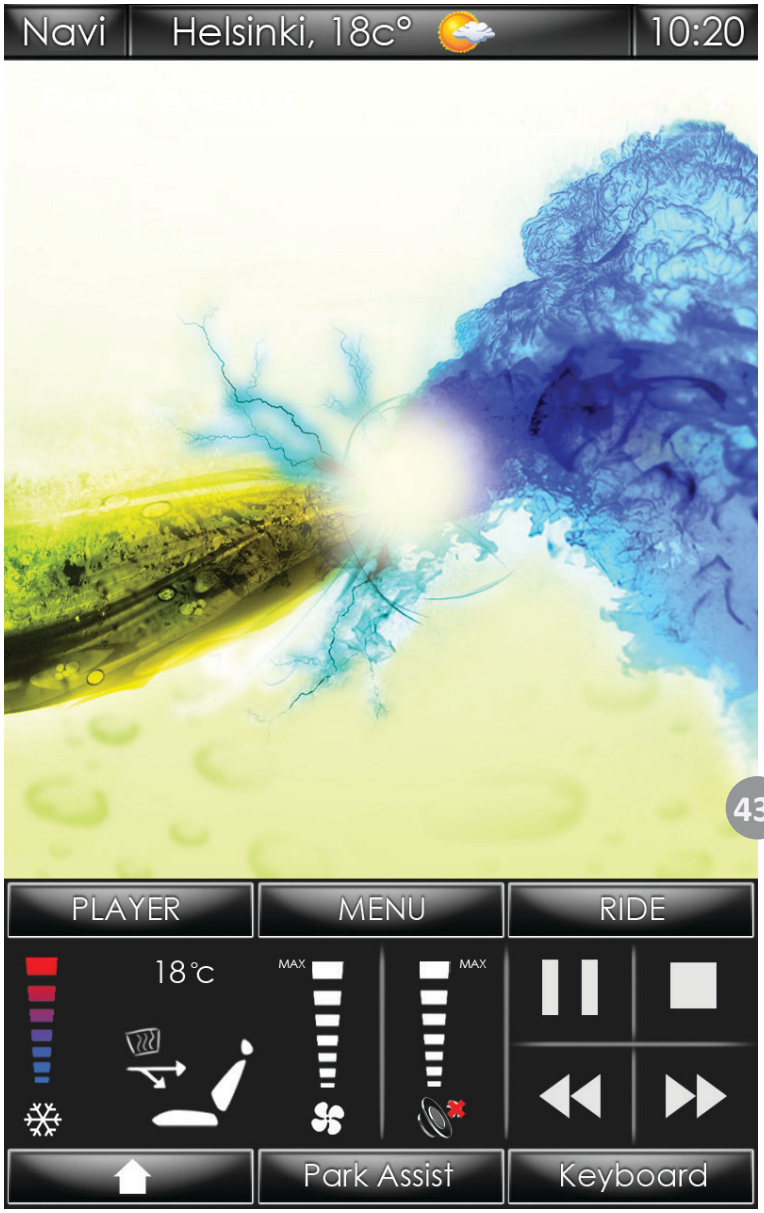
This button was initially meant to turn on and off the middle screen. While driving on a dark road the bright light coming from the screen could blind the driver. In my opinion it was very important to have a chance to adjust or to turn off the screen light.

The brightness issue was later fixed by using a lighting detector. The detector adjusted the screen brightness based on the lighting conditions inside the car.



43.

What the middle screen GUI will look like in the concept car once it is programmed.



Aesthetically the graphical appearance of the middle screen GUI is what some could call “boring”, but wait there is more. It does not bombard you with notifications from facebook either, nor does it receive text messages and emails and read them to you while you are driving. One could ask: “What does it do?” -The answer is simple, it is a graphical user interface for a car and that is what it does.

A “boring” simple user interface will most likely not cause it’s users to get distracted by it. That means that while your driving you can concentrate on the most important thing, the driving and that also helps make it safer. “Part of the problem is that driving while using your smartphone lacks the social stigma associated with driving while inebriated.” (Jeffries, 2014). Driving while using a smartphone could as well be compared to using the middle screen GUI, they both operate in similar ways.

2.1 Define & Research

2.2 References & Benchmarking

2.3 Concept & Test

2.3.1 Ideate & Sketch, Pt. 1

Desktop & Functions

Menu logic

Interior lights & Dial controls

Dials & Rear-view mirror

2.3.2 Customer research

2.3.3 Process & Fix

2.3.4 Ideate & Sketch, Pt. 2

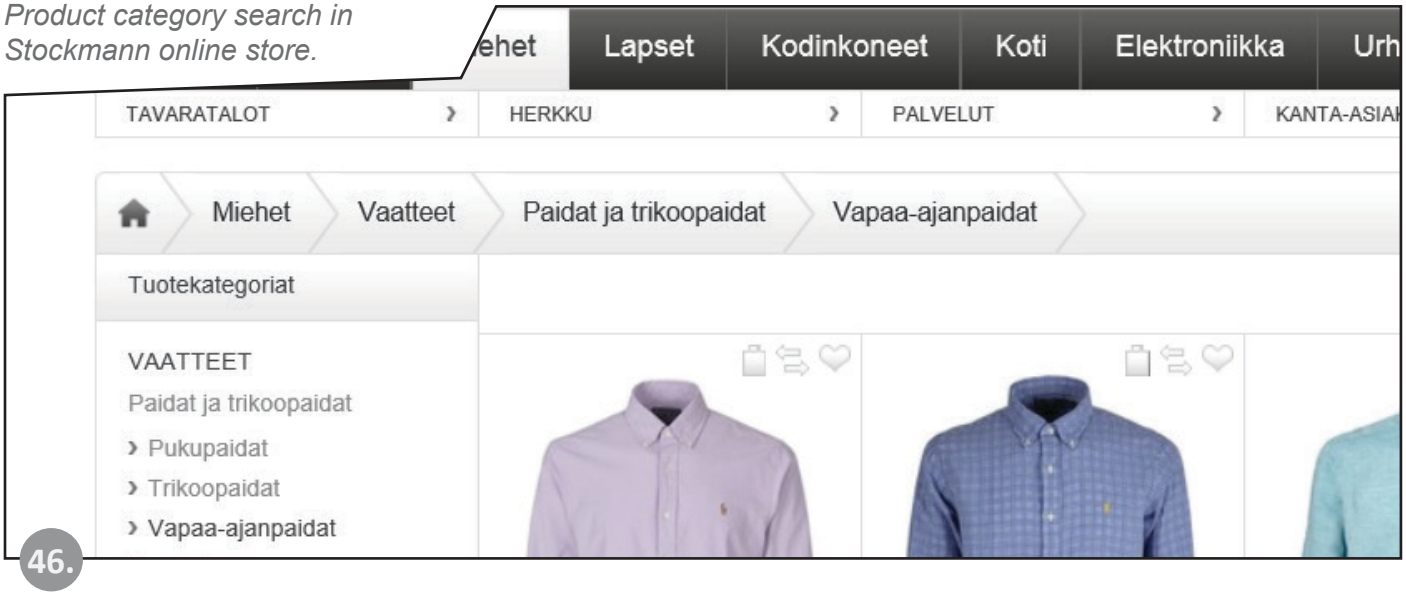
The GUI menu logic came from the same type of logic that can be found in various computer UIs as shown in the images below.

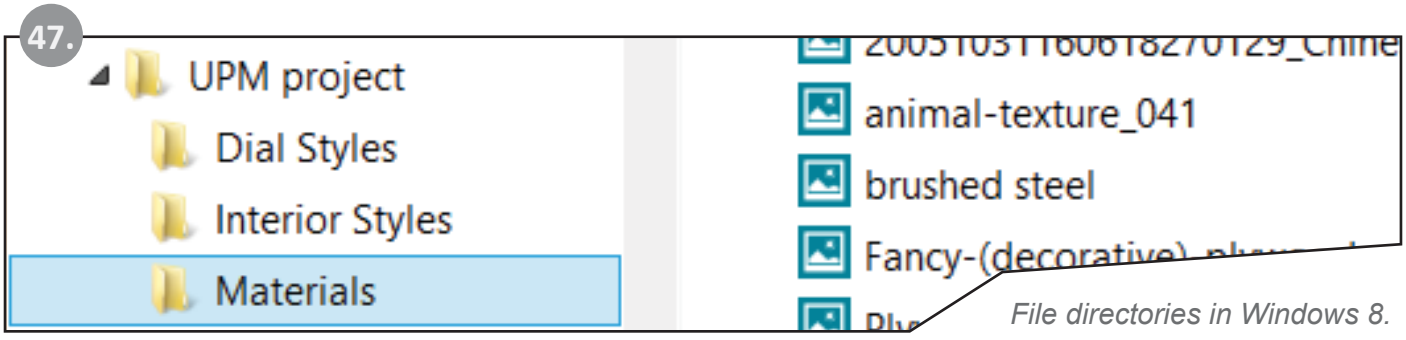
The same type of logic is also used in some separately sold navigators (SSN) as seen in image 91, the search paths in online stores and file directories in computers.

Program exit in Adobe InDesign.

Exit button in Windows 7.

Product category search in Stockmann online store.

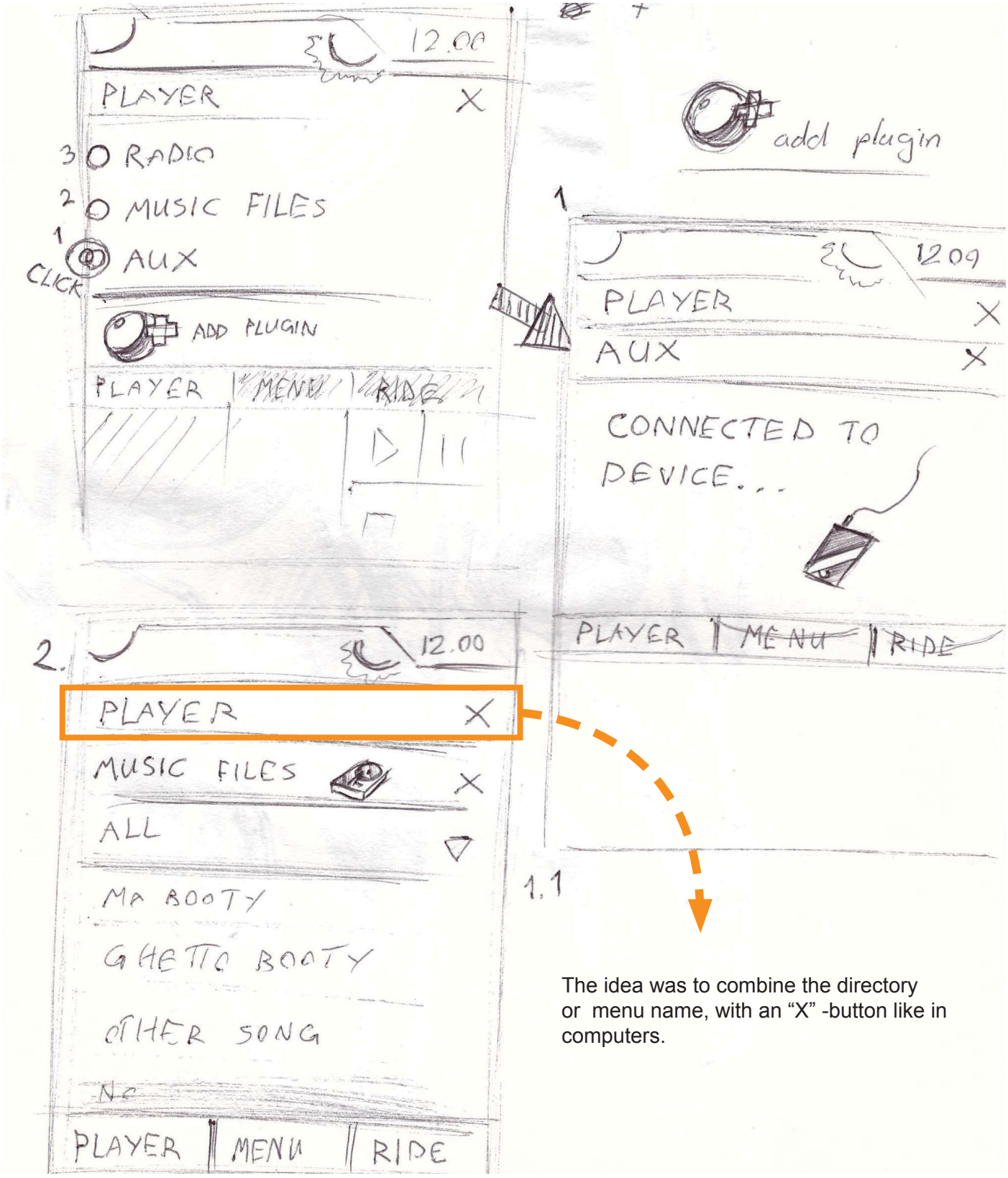




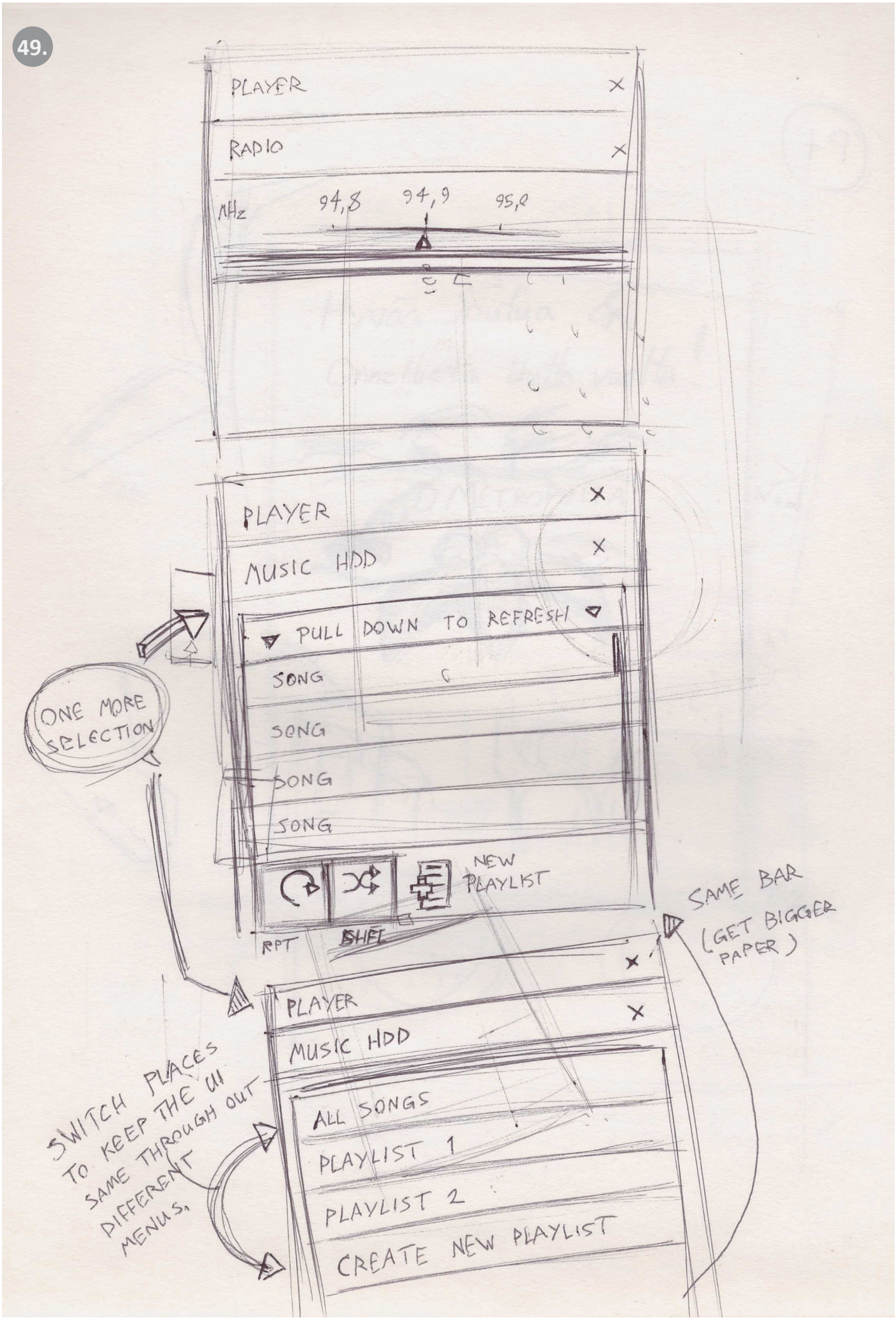
File directories in Windows 8.

Testing the menu logic by sketching the player menu.

48.



The idea was to combine the directory or menu name, with an “X” -button like in computers.


PLAYER
RADIO
MHz
94,8
94,9
95,0
PLAYER
MUSIC HDD
PULL DOWN TO REFRESH
SONG
SONG
SONG
SONG
NEW PLAYLIST
RPT
SHFL
ONE MORE SELECTION
SAME BAR (GET BIGGER PAPER)
PLAYER
MUSIC HDD
ALL SONGS
PLAYLIST 1
PLAYLIST 2
CREATE NEW PLAYLIST
SWITCH PLACES TO KEEP THE UI SAME THROUGH OUT DIFFERENT MENUS.

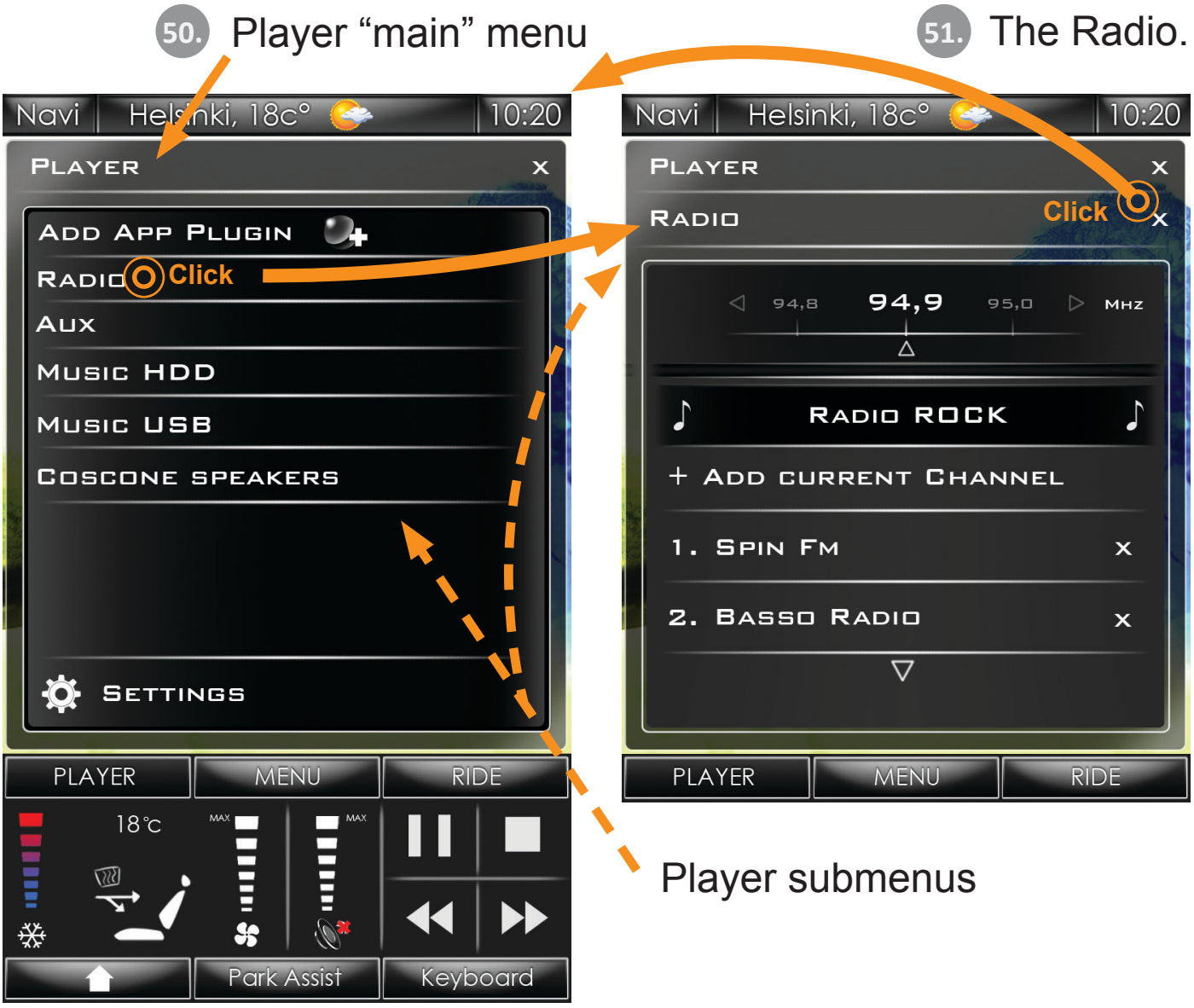
The menu logic used in the IVI.

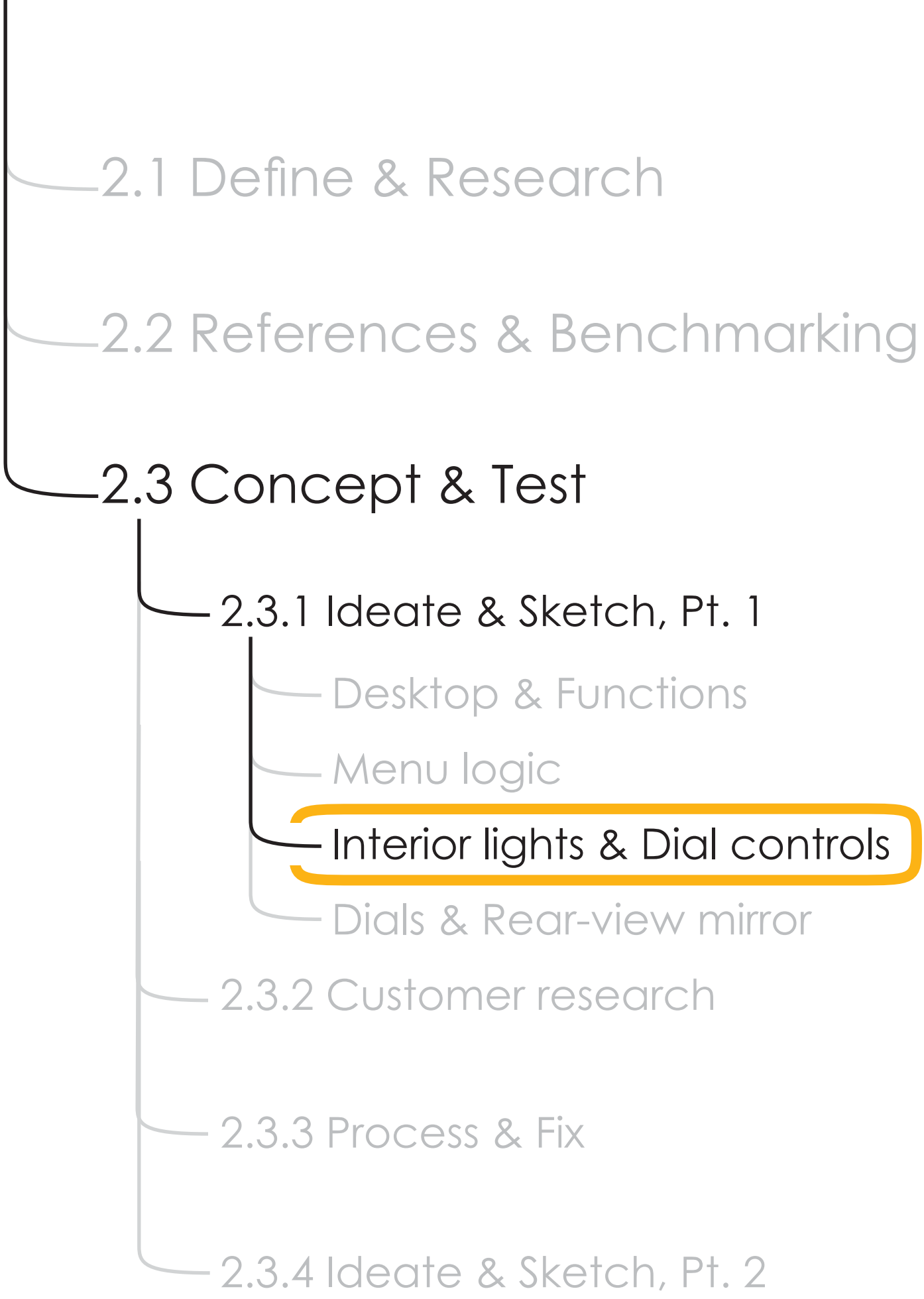
All menus, like the player menu below on the right, consist of an X amount of submenus. The submenus take you to different functions within the “main” menu.

Clicking on any one of the submenus opens it.

Clicking on the “x” at the right corner of the “main” menu closes the entire window, bringing you back to the desktop.

Clicking on the “x” at the right corner of a submenu takes you back to the previous submenu, or the “main” menu.



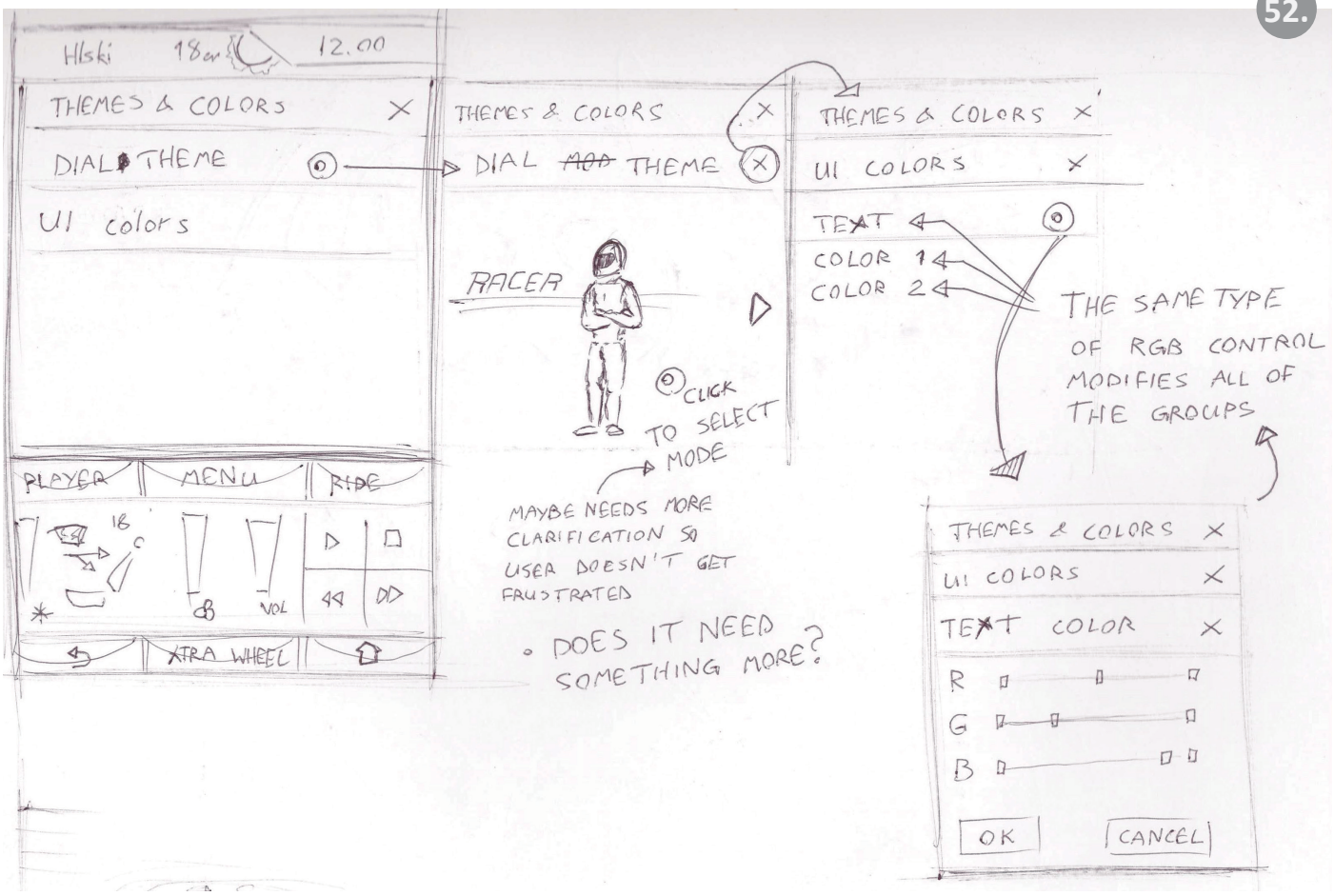

2.1 Define & Research
2.2 References & Benchmarking
2.3 Concept & Test
2.3.1 Ideate & Sketch, Pt. 1
Desktop & Functions
Menu logic
Interior lights & Dial controls
Dials & Rear-view mirror
2.3.2 Customer research
2.3.3 Process & Fix
2.3.4 Ideate & Sketch, Pt. 2

The Biofore concept car was designed to have ambient interior lighting. The interior lighting was made by installing Red-Green-Blue (RGB) LED strips in the interior of the car. The color the RGB LED's produce can be controlled by giving a numeric value for each of the three colors.

At first I thought of combining the interior lighting controls with the dial layouts. The idea was to basically combine the interior colors and different types of dials into groups that would be named by their content. For example and old school -type of speedometer dial layout with a matching interior lighting color would have been named after the type of user, as seen in images 55-58. However I quickly deducted that a classification like this would not work, because I felt that it could frustrate the users. (Some of the user types can be seen in the next page.)

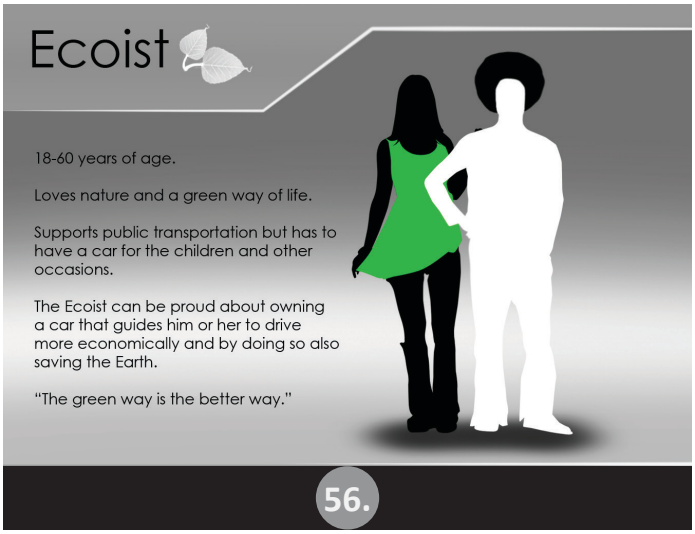
A sketch of how the Dial looks and the interior lighting could be controlled.

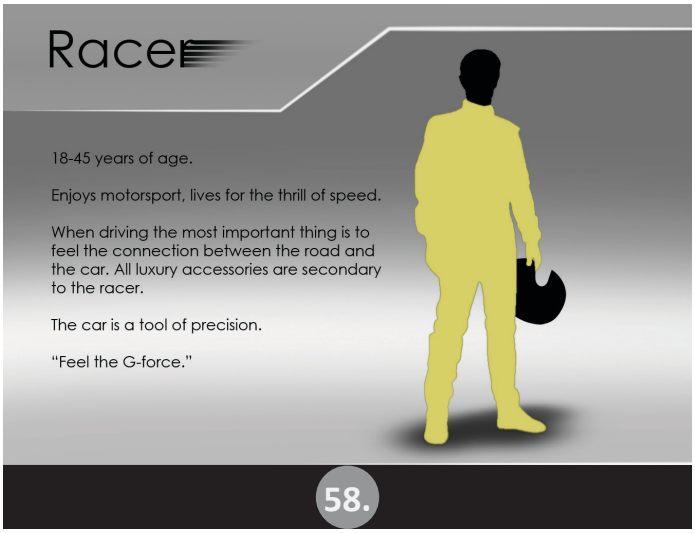
52.



After some processing I decided to split the Dial look and interior lighting controls into their own submenus. As shown in picture 52 above. I also made digital sketches of this method of controlling the interior lighting and the dial themes. (See images 53 and 54 in the next page.)

Classifications of the Dial and Interior lighting combinations.



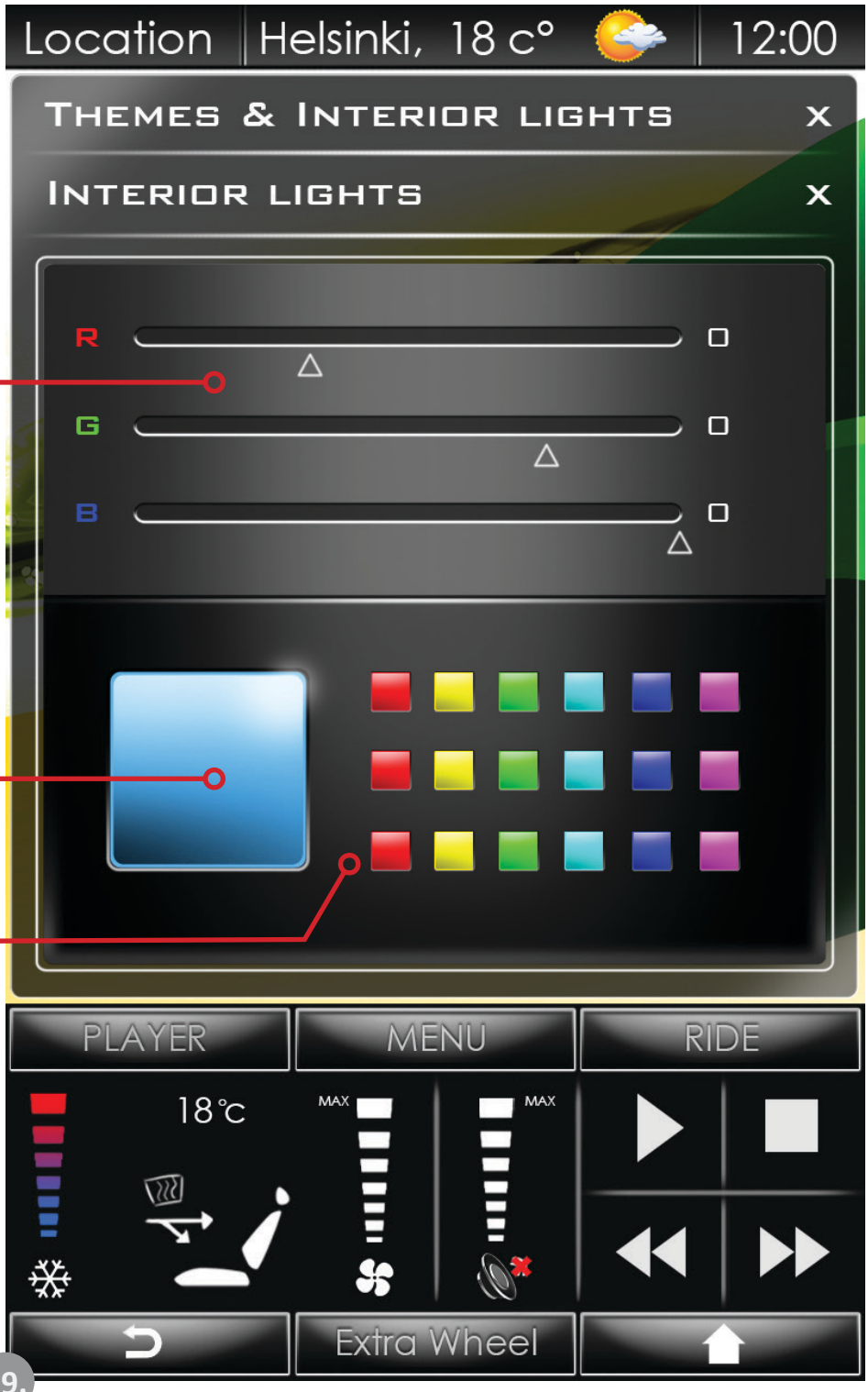


It was quite easy to deduct what kind of a UI had to be designed in order to change the interior lighting with the RGB LED strips. As a frequent user of Adobe products, I thought that the best way to change colors would be to create a slider for each of the three colors. That way the user could pick a color he or she liked by simply moving the sliders for the red, green and blue variables. Once the user would move the sliders they would see the color change in the larger “active color display.” For some users basic colors might be enough, so for them a range of preset colors were placed next the the “active color display.”

Color sliders

Active color display

Preset colors



59.


2.1 Define & Research
2.2 References & Benchmarking
2.3 Concept & Test
2.3.1 Ideate & Sketch, Pt. 1
Desktop & Functions
Menu logic
Interior lights & Dial controls
Dials & Rear-view mirror
2.3.2 Customer research
2.3.3 Process & Fix
2.3.4 Ideate & Sketch, Pt. 2

The concept car had no ordinary rear-view mirror placed at the top of the windshield, even though It is a compulsory driving instrument in a vehicle. It was my job to integrate an image of the rearview mirror that a camera shot at the back of the car into the IVI.

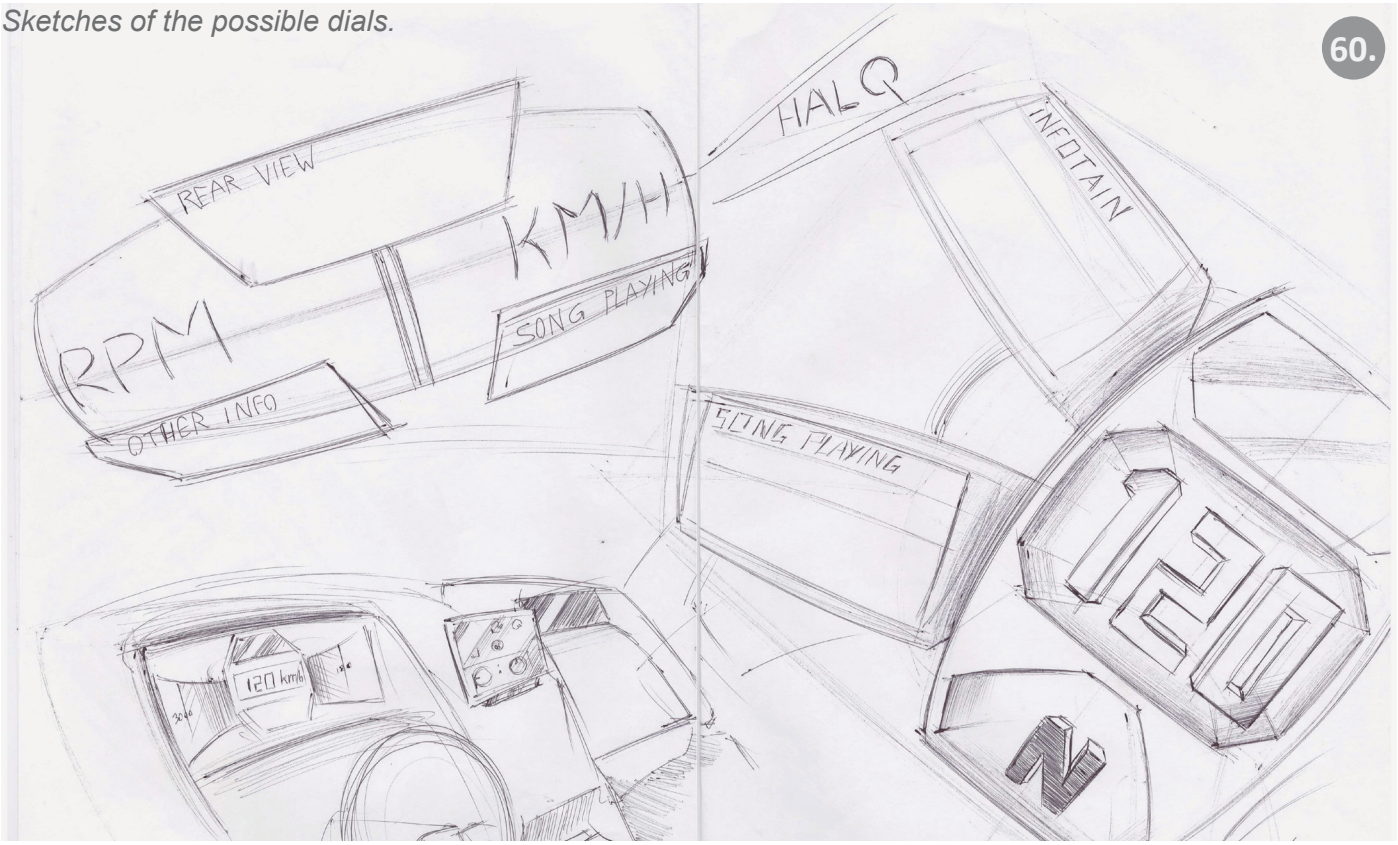
When seated in a car the driver positions himself so that he or she can see out through the windshield and still has more than adequate visibility in every other direction. When driving normally, the driver mainly concentrates on things happening in front of him. The driver also has to look at the side mirrors and the rear-view mirror in order to know what is happening around him and be aware of the things happening in the IVI. (Warnings, current speed, etc.)

In the beginning I thought of having the rear-view mirror in the middle screen. On the up side, it would have placed the rear-view mirror image in close proximity to where an actual rear-view mirror would be. On the down side it would have only diminished the space I have for all the other functions in the middle screen. It would also have needed a much longer interaction from the driver to get an image of what is behind him.

When driving a normal car, sometimes the driver would have to repeat a pattern of movement that gives him visibility into all four directions, left, back, right and front. When you calculate the time the driver needs to actually realize what is going in each of those directions, it adds up to at least a second and a half per direction for most drivers, plus the time it needs for the driver to switch directions. I saw this four way pattern as an unnecessity. The fact that we have no rear-view mirror already removes a step from that pattern, why should I try to put it back there?

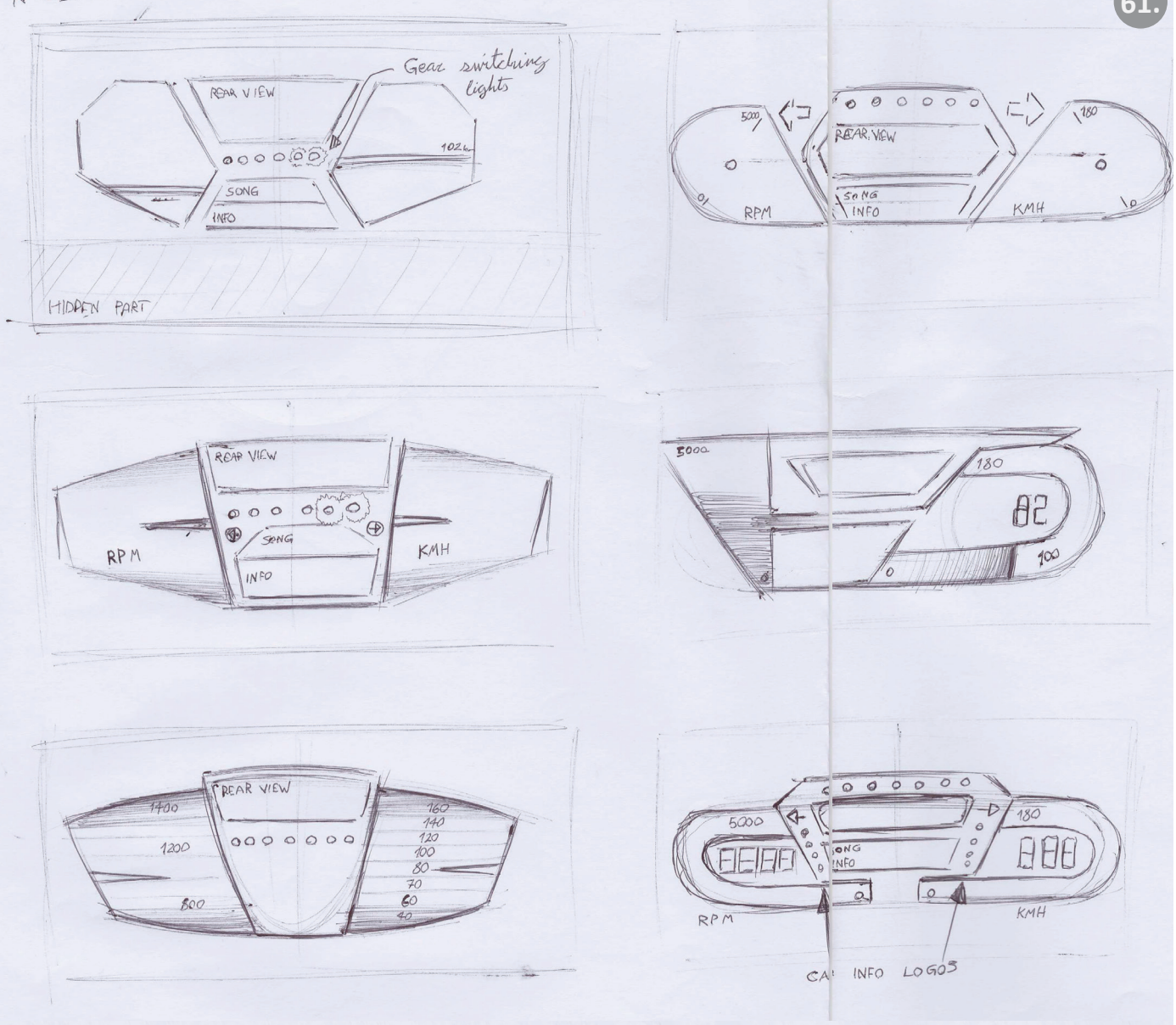
A good way of minimizing the amount of unnecessary of movement for the driver but still keeping the information that is necessary to him or her easily available, was by uniting the rear-view mirror and the dial console. That way the driver only needed to look down a little to see what is going on behind the car.

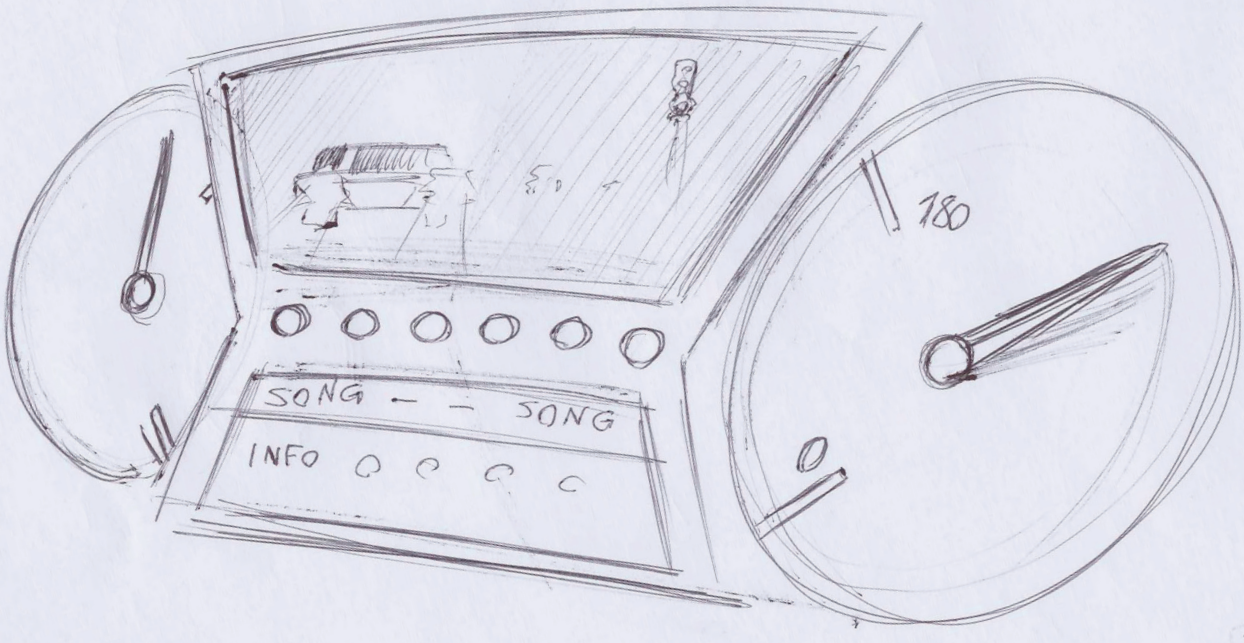
Sketches of the possible dials.

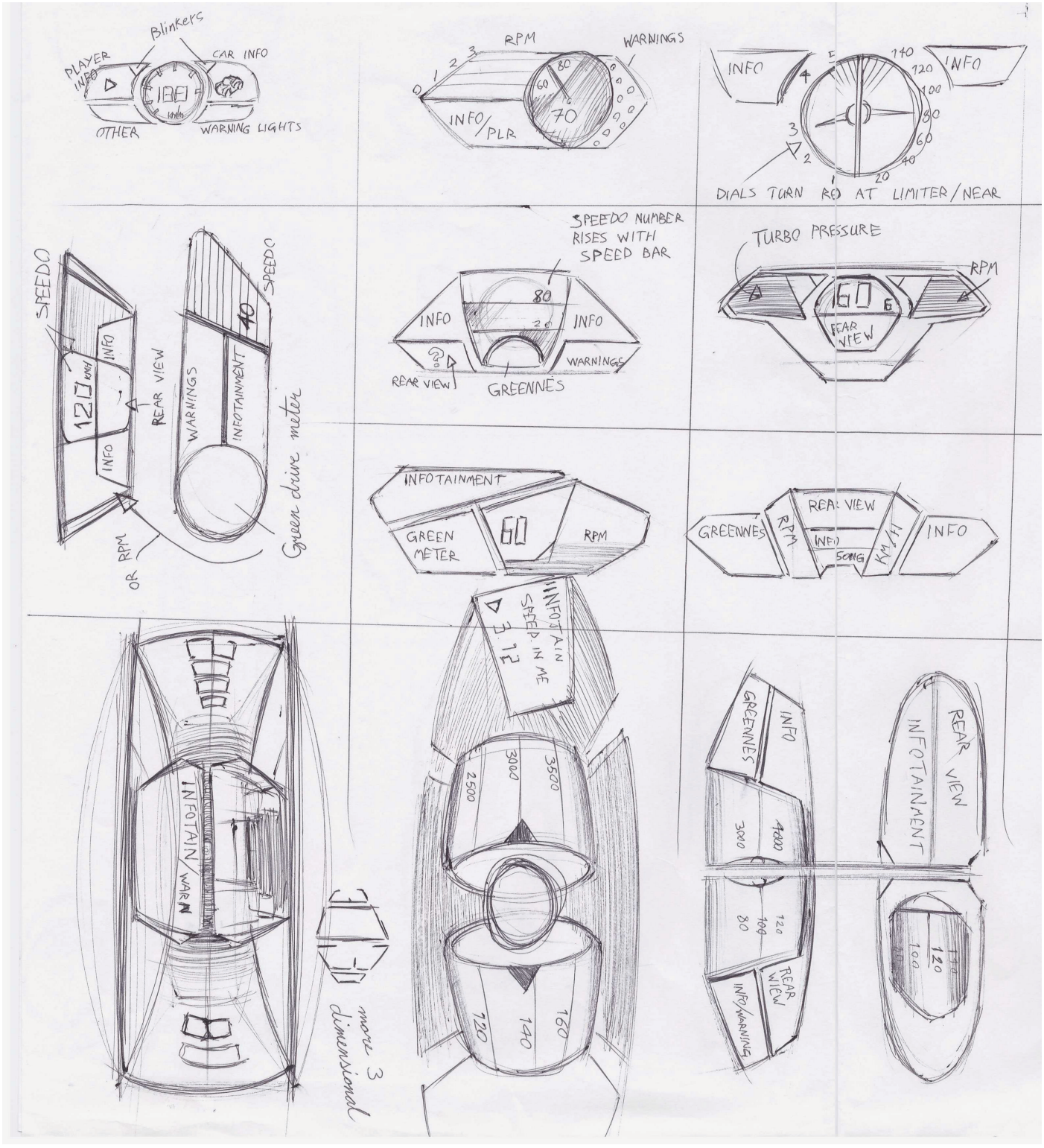


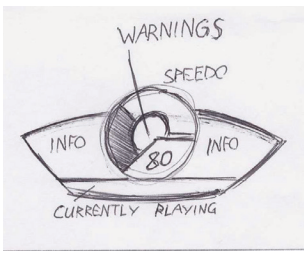
RACER

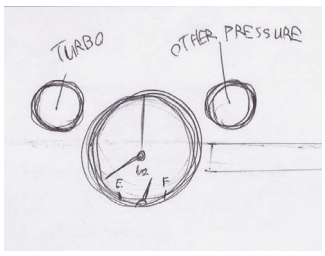
61.

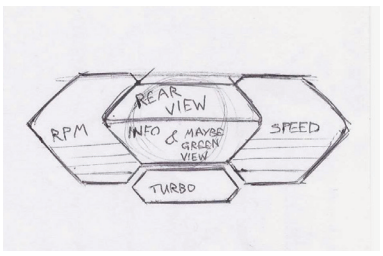

Gear switching lights
REAR VIEW
SONG
INFO
HIDDEN PART
REAR VIEW
RPM
KMH
SONG
INFO
REAR VIEW
RPM
KMH
SONG
INFO
REAR VIEW
RPM
KMH
INFO
LOGOS

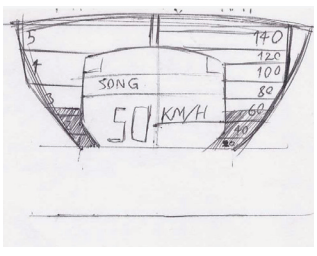

SONG
SONG
INFO

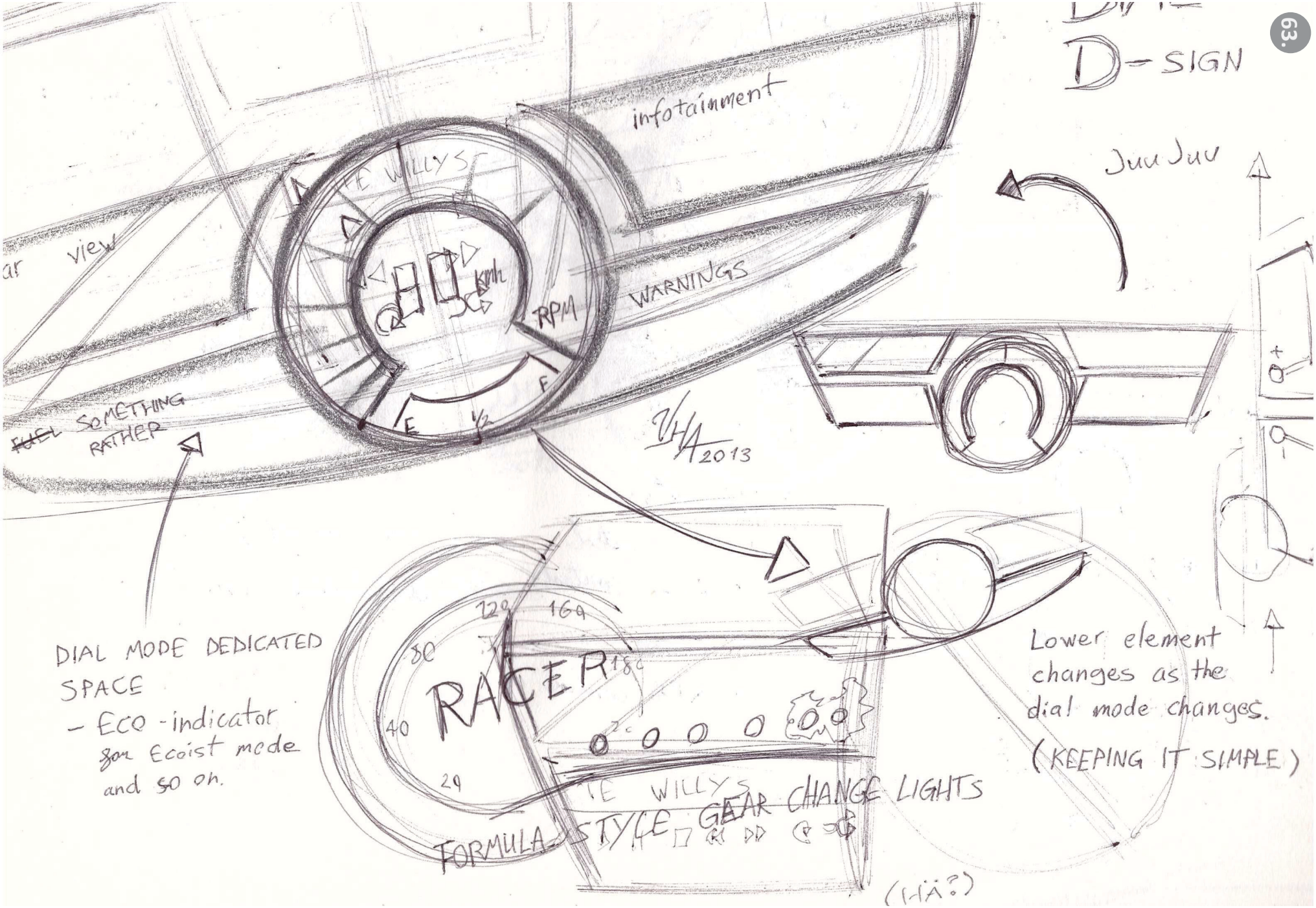

Blinkers
PLAYER INFO
CAR INFO
OTHER
WARNING LIGHTS
RPM
WARNINGS
INFO/PLR
INFO
INFO
DIALS TURN RED AT LIMITER/NEAR
SPEEDO
SPEEDO
INFO
INFO
REAR VIEW
WARNINGS
INFOTAINMENT
Green drive meter
RPM
OR
SPEEDO NUMBER RISES WITH SPEED BAR
INFO
INFO
WARNINGS
REAR VIEW
GREENNES
TURBO PRESSURE
RPM
REAR VIEW
INFOTAINMENT
GREEN METER
RPM
GREENNES
RPM
REAR VIEW
INFO
SONG
KM/H
INFO
INFOTAIN/WARN
more 3 dimensional
INFOTAINMENT SPEED IN ME
GREENNES
INFO
REAR VIEW
INFOTAINMENT
INFO/WARNING


WARNINGS
SPEEDO
INFO
INFO
CURRENTLY PLAYING

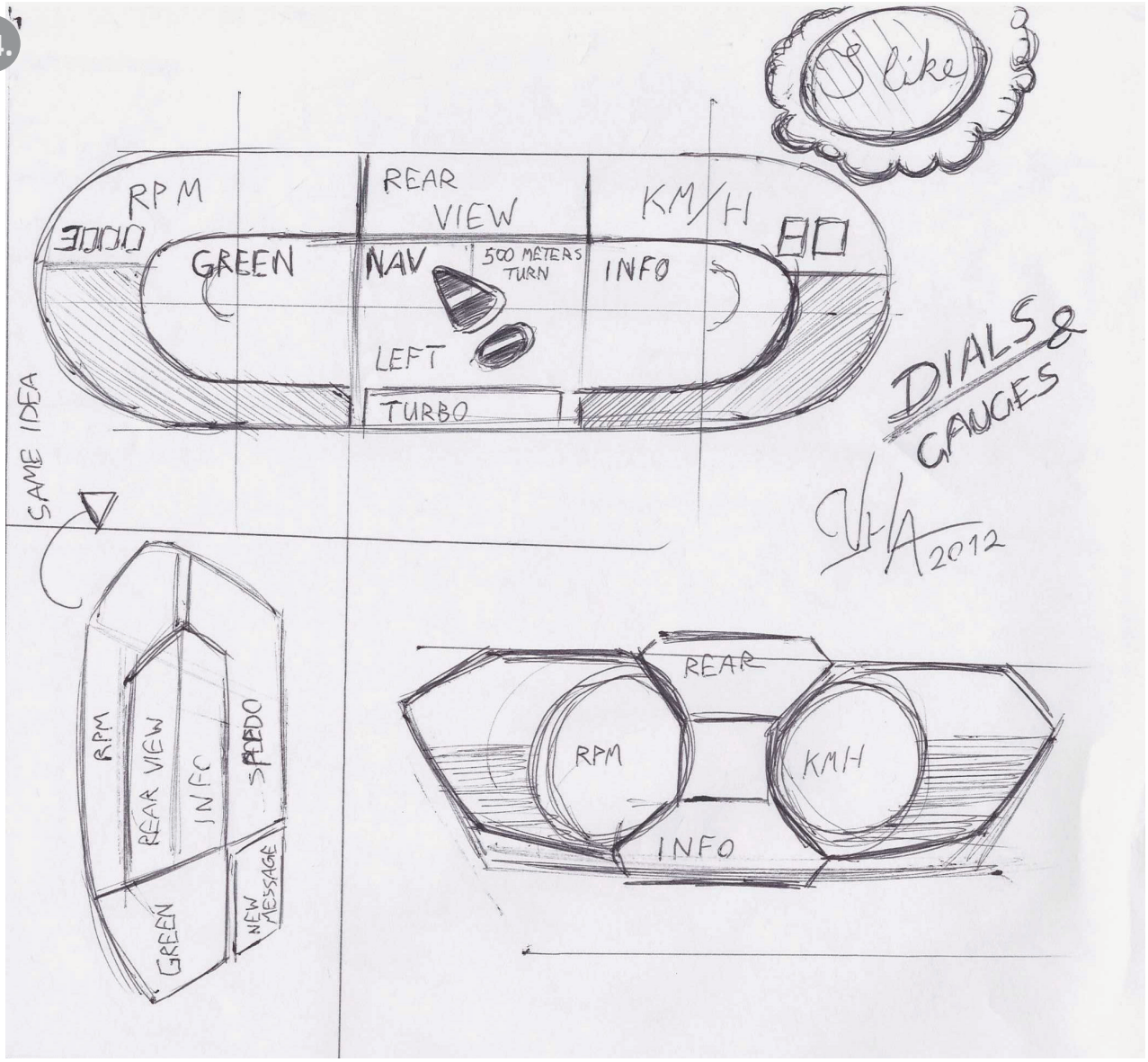

TURBO
OTHER PRESSURE


REAR VIEW
RPM
INFO & MAYBE GREEN VIEW
SPEED
TURBO


SONG
KM/H

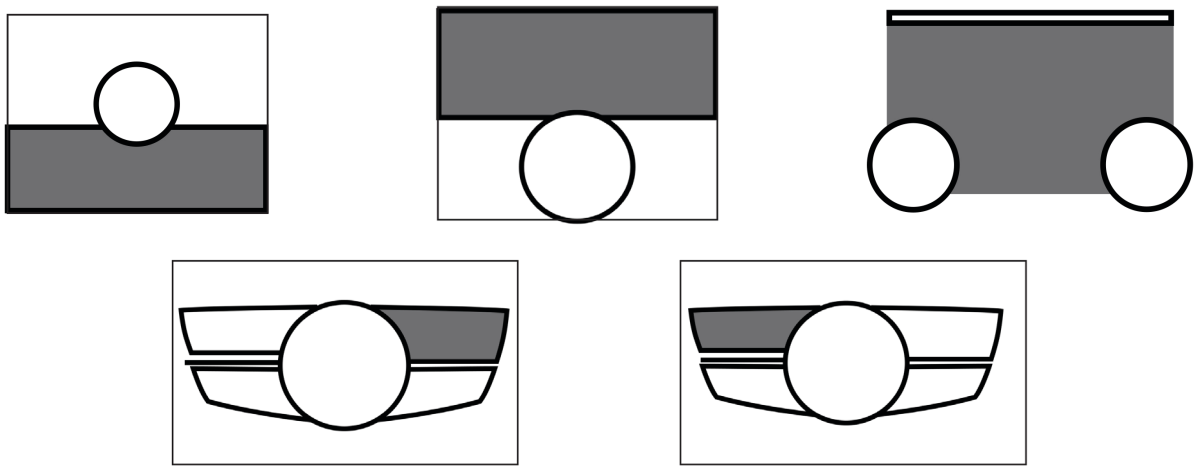

D-SIGN
infotainment
WARNINGS
RPM
kmh
E
½
F
FUEL SOMETHING RATHER
DIAL MODE DEDICATED SPACE
- ECO-indicator for Ecoist mode and so on.
RACER
FORMULA STYLE GEAR CHANGE LIGHTS
(HÄ?)
Lower element changes as the dial mode changes.
(KEEPING IT SIMPLE)

64.



Uniting the dial console and the rear-view mirror seemed like the natural choice. I wanted to know what the probable drivers of a car like ours thought. I made quick pictures about different types of console layouts that all incorporated the rear-view mirror in different sizes and locations with either one or two dials.

65.



2 Process

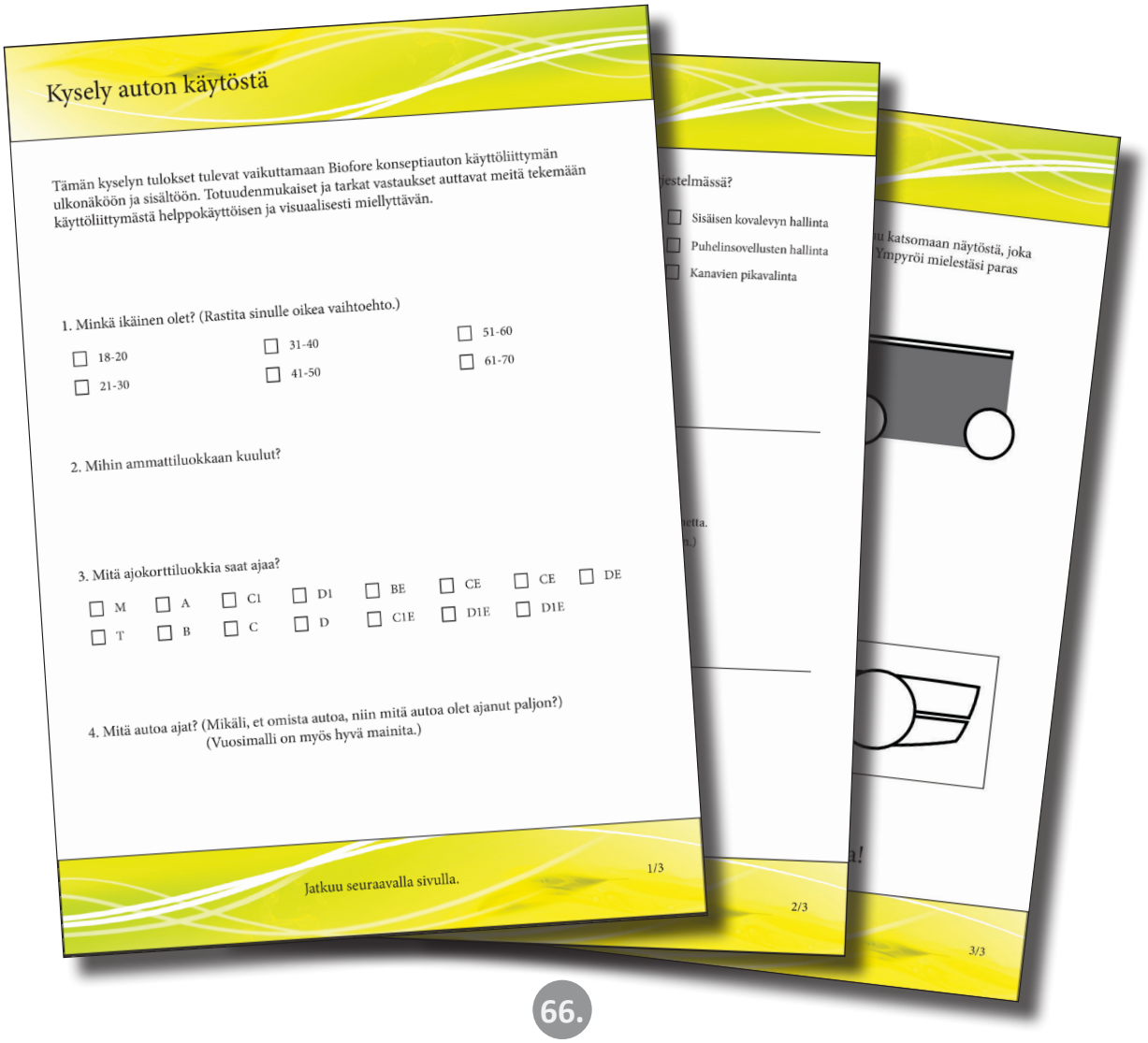
2.3.2 Customer research

Sketching the UI and thinking about the possible dials helped me amass a list of questions, about how certain things would be displayed, if at all. Those questions needed answers that only the target users could give.

I needed to find out what kind of features people used in their car's UI. Did they use the radio or a multimedia interface? What functions did they use from that interface? How did they use the radio? Did they use their car's onboard computer? How often? What things did they view? What would the users want to know from the onboard computer drive- or trip oriented or otherwise? Facebook status updates, emails, on route commercials from coffee shops or gas stations?

> "Before designing a Designer seeks to find out the understandings and hopes of the users. As the design process progresses devices and UI:s are developed with the users, for example by testing alternative ways to show information. This is how UI:s are designed to meet the needs and expecta tions of the users." (Launis, 2011 ,235).

Based on the design guideline by M. Launis I made a survey and began looking for people who were in our target group, and who had a valid driver's license to participate. The survey itself and it's results are attached to the end of the thesis.



66.

2 Process

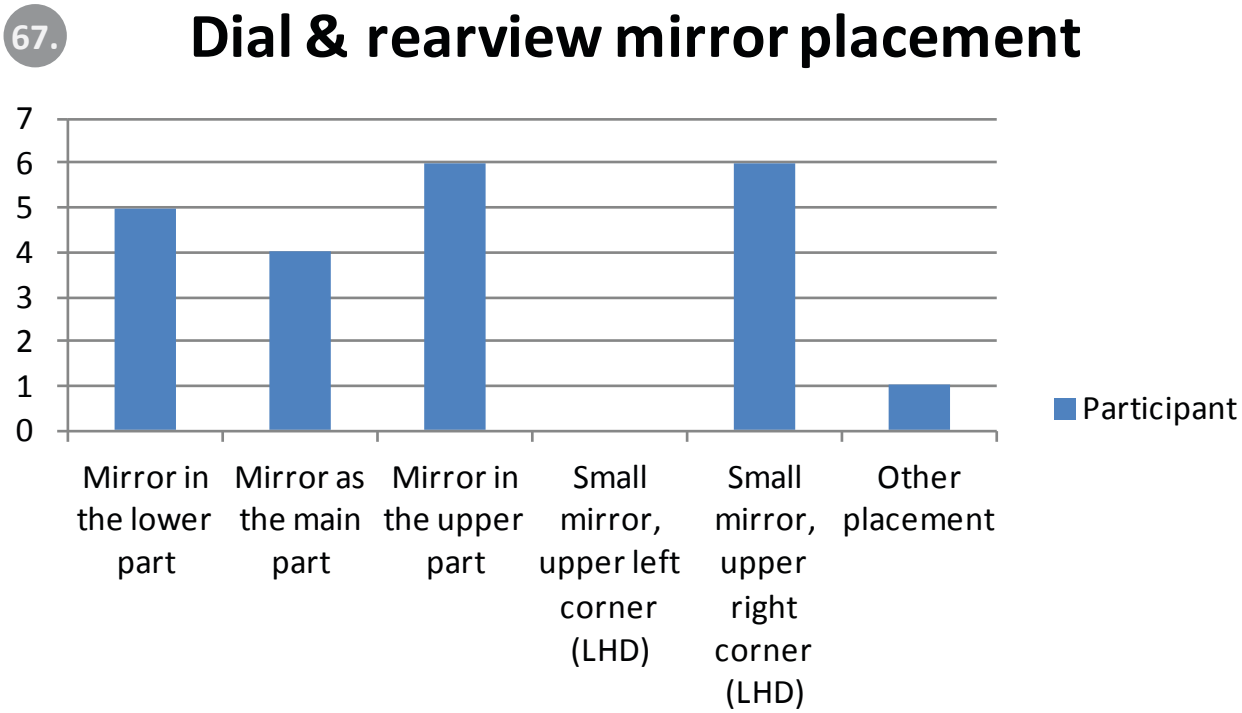
2.3.3 Process & Fix

The customer research itself was quite narrow, 22 people took part in the survey. 60 percent of them were from 21-30 years of age, two were from 61-71, and the rest were from 31-60 years of age. I felt that having a few people attend the survey from outside my target group could prove to become valuable at some point. After all, the cars that have been designed with under 30 year old users in mind are in many cases driven by people who nearly double that age. Maybe the survey results from the few attenders from outside my target group would give some insight into why.

Because the research was so narrow I cannot call the results in any way definitive. However I believe that many enough people took part to get an image of what a much larger group would have answered. Partly because one of the questions the participants had to answer was: “What would be the best way to display the rear-view mirror in the car’s dial console?” The participants were given five options to choose from.

The answers I got were quite surprising, I thought that one of the options I had given would clearly rise above the rest, but that did not happen. Instead the participants created a nice dispersion. Two of the given dial layouts beat the other options, some by merely one or two votes.

Since the aim of my thesis was to create a system that better connected the driver to their car. The results brought me to an epiphany about how I could enrich the UX even more. I started thinking of possibilities to supply the users with multiple dial layouts, so they could all choose what they like best. The only problem was that the users would have to go through a tiresom process of switching the dials and other preferences like interior lighting before they could drive “their own” car. I had to create a solution to fix this.

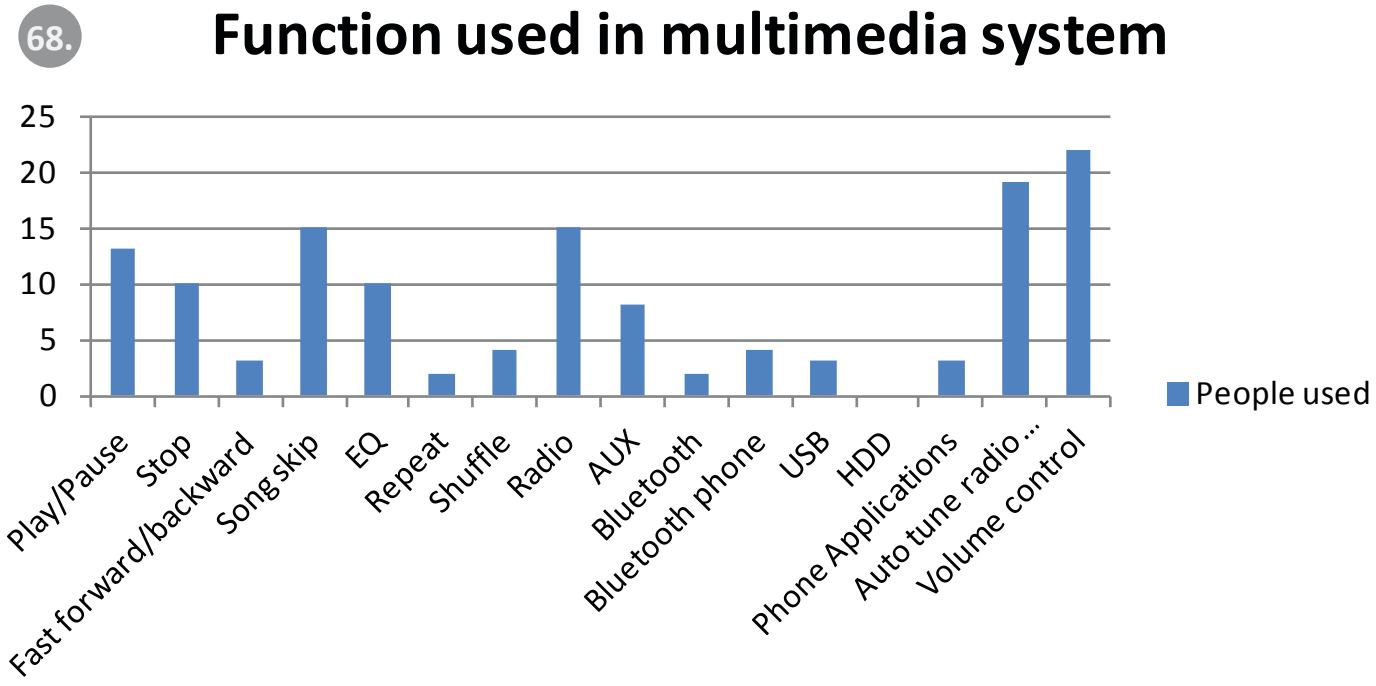


The name “Main Activity Window” (MAW) came after the customer research confirmed my thoughts about most drivers using certain functions in their car’s multimedia systems and other driving task- and driving comfort related areas. As can be can seen in the chart below, nearly all of the 22 survey participants used a radio channel autotune function to scroll through available radio channels and 15 of them used a song skip foward or backward function. All of them used their cars AC or heater controls and player volume controls.

From the results I deducted that the fixed placement for the most important menus and the controls for the AC and the media player should be called the “Main Activity Window” as it’s contents are frequently used while driving the car.

The MAWs location on the middle screen was based on the screen’s position in relation to the driver. In a normal seated position from where the driver would drive the car, the screen was still at a very long distance from him or her. I wanted to make sure that the most used functions would be easily available.

68.



See the separate document “Menu tree & MAW” for further information about the IVI menu structure and the MAW.

2 Process

2.3.4 Ideate & Sketch, Pt. 2.

Dial layouts

After processing the results of the consumer research I came to a conclusion that making multiple sets of dials with different placements of the rear-view mirror, speedometer and so on, would allow me to create something hopefully for every user. One of the things I had to keep in mind was that the warning icons and other icons found in a car, like the blinker signs, had to resemble the ones in cars that are already being manufactured.

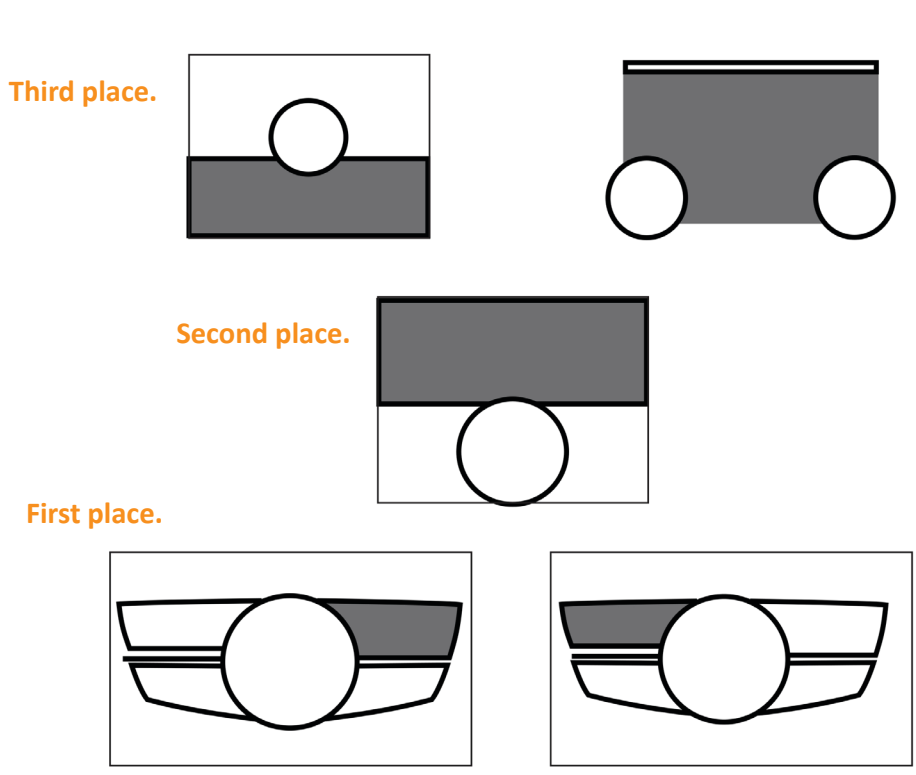
Three of the layouts rose above from the rest. The most obvious layout chosen was the one that closely resembled the situation we currently have in most cars. Where the rearview mirror could be found in the upper right corner of the driver's point of view. Only in my picture the rearview mirror had a small space in the upper right corner of the driver's screen (When the driver sits on the left side of the car).The second layout that was tied for the first place had the rear-view mirror sitting on the upper half of the screen.The third place was granted to a layout that had the rear-view mirror as the bottom half of the driver's screen.

Seeing that my test group, which consisted of people from five different age groups and many different backgrounds did not come to a common conclusion about the rear-view mirror's position on the screen. I had a chance to enrich the UX even more. The aim of my thesis was to design an IVI system that would better connect the users to their car. What better way is there than to give the user a chance to customize the GUI he or she sees? With the dial console being one of the customizable elements it gave me the freedom to create something, not for all, but hopefully something for everyone.

Before designing the final dials, I needed to choose a structure that all the dials would follow. In image 69. you can see how the "Orange" dial is constructed. All the designed dials after this point contained the same five elements in differing set-ups.

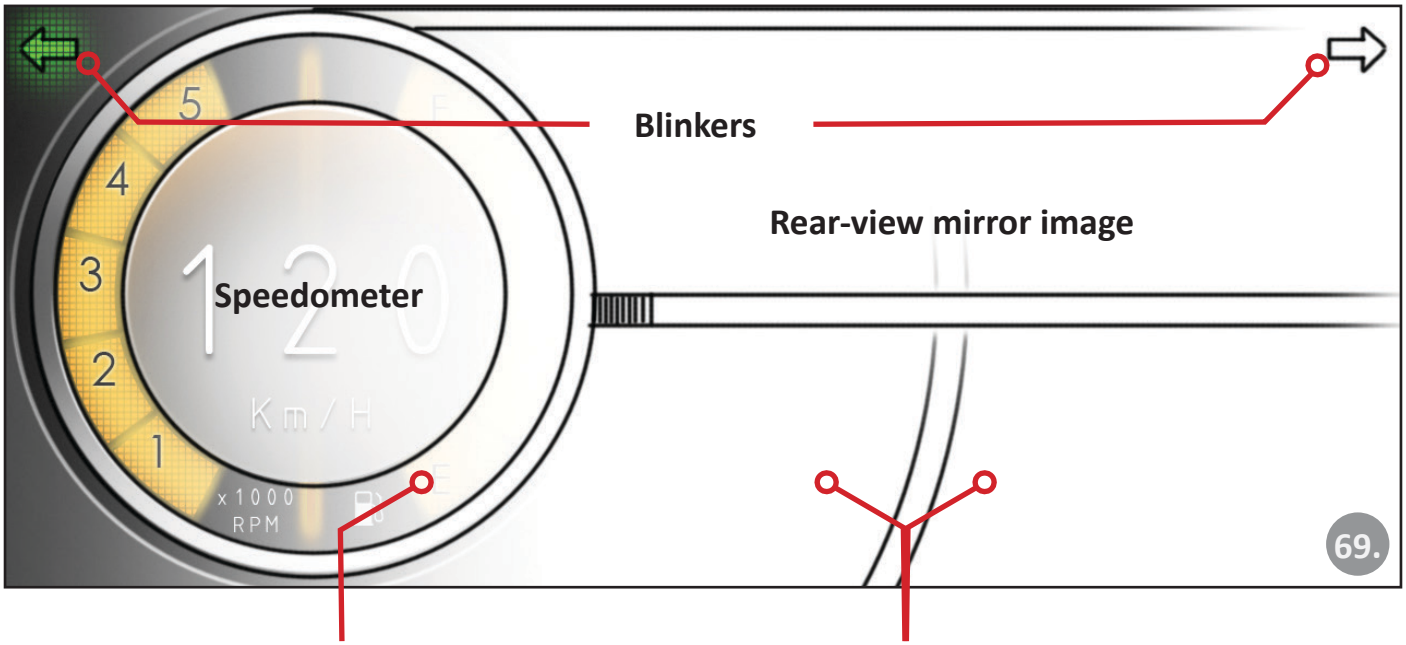
The five rear-view mirror placement options given in the survey.

65.



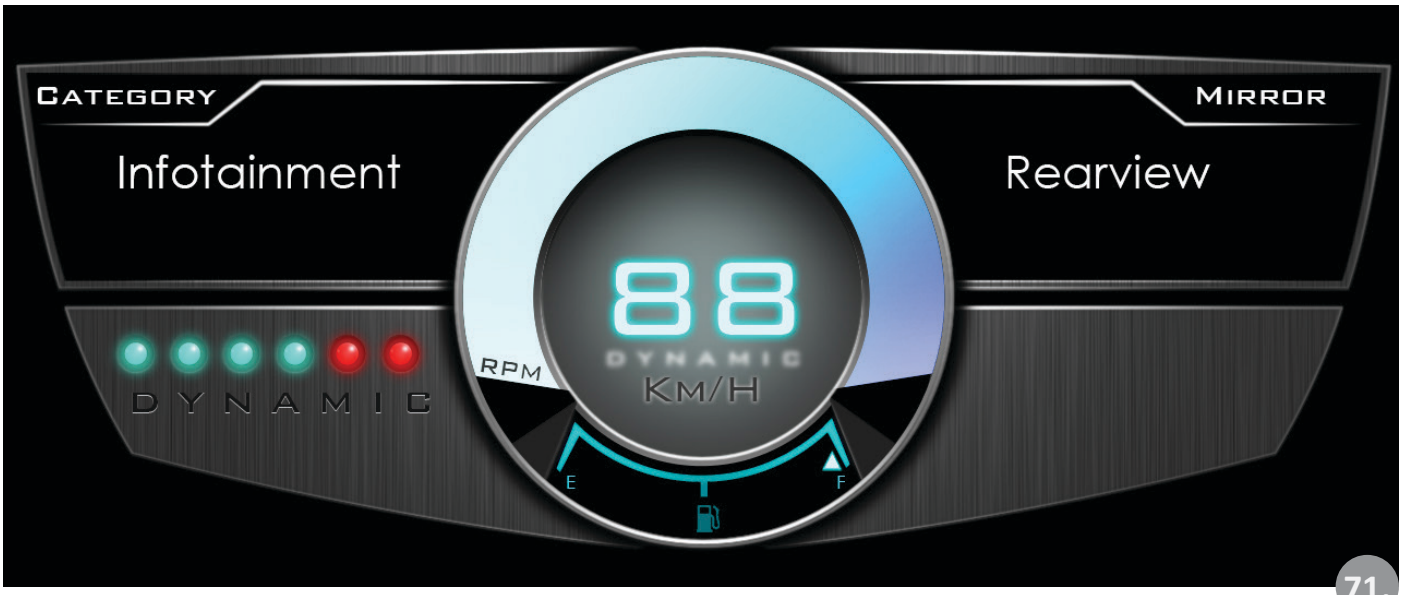
1. Blinkers, usually at the upper or lower ends of the screen. Right blinker in the right corner and the left blinker in its own.
2. The area for the rear-view mirror image.
3. A speedometer, usually with the speed in writing for precision.
4. An additional area containing other important information. Information like the fuel gauge, or a rounds-per-minute display.
5. One or two additional information screens. For viewing the information the driver would like to see while driving. For example, navigational information, a small view showing what song is playing or an average consumption meter.

The five elements that build a dial layout



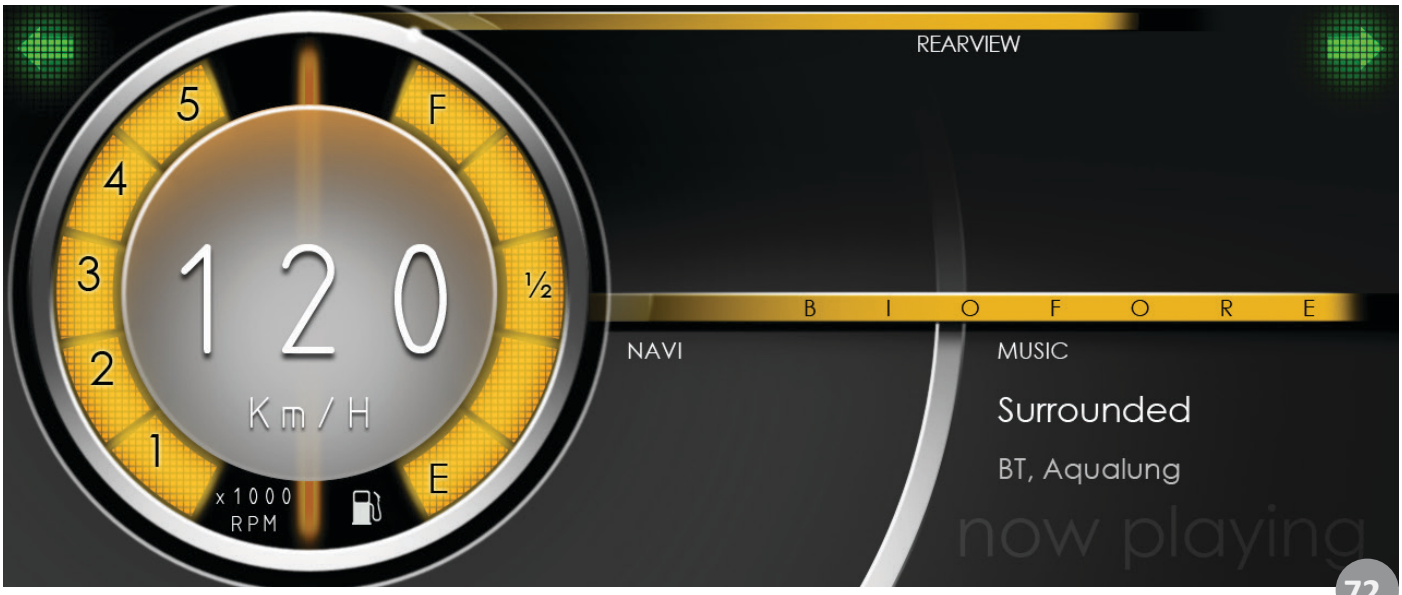
In case there is an emergency with the car. For example if the engine is running out of oil. The IVI will use the additional infotainment areas to warn the driver. (See picture 70.) All warnings are accompanied by a vocal message or a “ping” to help make sure that the driver notices the warning.

Designed dials



71.

"Dynamic"

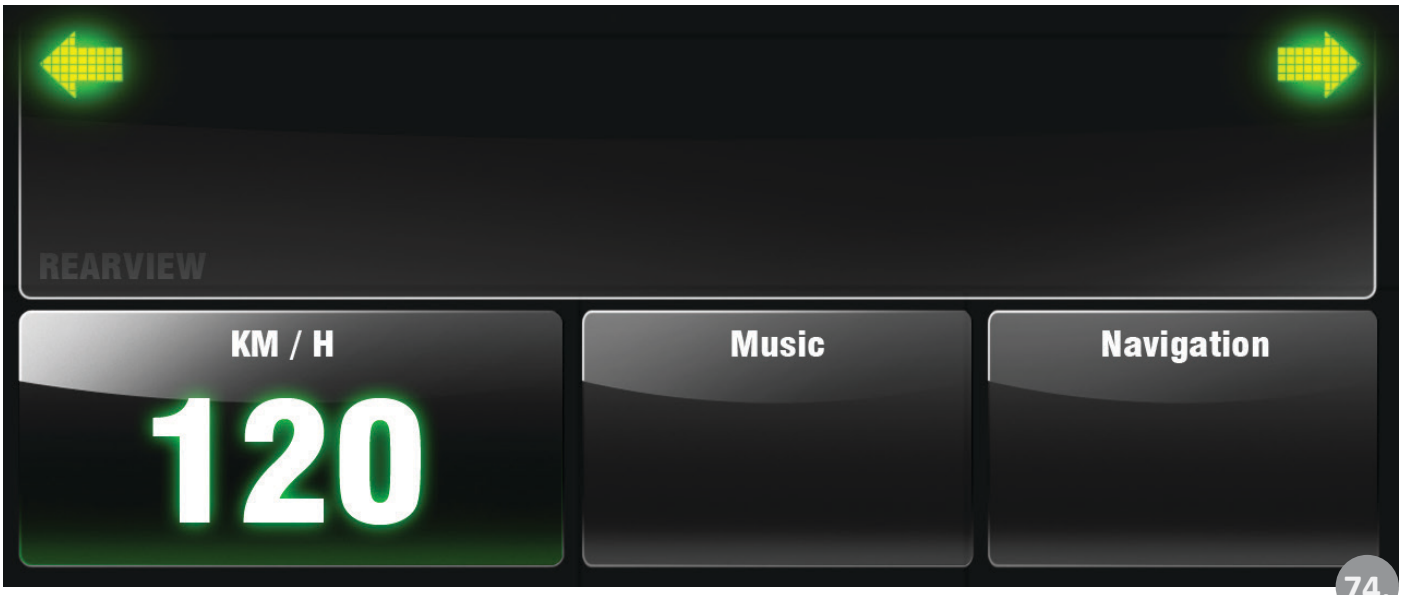


72.

"Orange"

"Blue"

73.



74.

“Windows”

75.

“Old school”

“Futuristic”

76.

Smartphone application

After processing the results of the customer survey I began thinking more about the target users and thought of a scenario where there would be multiple people driving one car. It is a plausible situation because the target users are very environmentally concious and therefore they might prefer to use a shared car with their friends. Maybe it could even be a company car that employees use.

Thinking about the solution to how control the users preferences, produced an idea of giving the users a calling card that would have their profile in it. The only problem was the fact that maybe the users did not want to carry anything extra. At the least they already carried their home and work keys, wallets and smartphones with them. Smartphones, what would be a better way connect the users to their car than a smartphone application. The users could customize their preferences from the comfort of their homes. Picking the dials, the color of the interior lighting and even presetting their favourite radio stations and saving their favourite map locations into the application. Volvo already had a smartphone application with which you could navigate to locations that you had saved onto your smartphone. (See page 27 for further information.)

Once the user got to the car he or she could simply connect to it via a wireless internet connection or through bluetooth. After that the car would switch to the users preferences and they would be on their way, in their own car.

Screenshots of the mobile application and a flowchart of how a list of your preferences would be sent to your car.

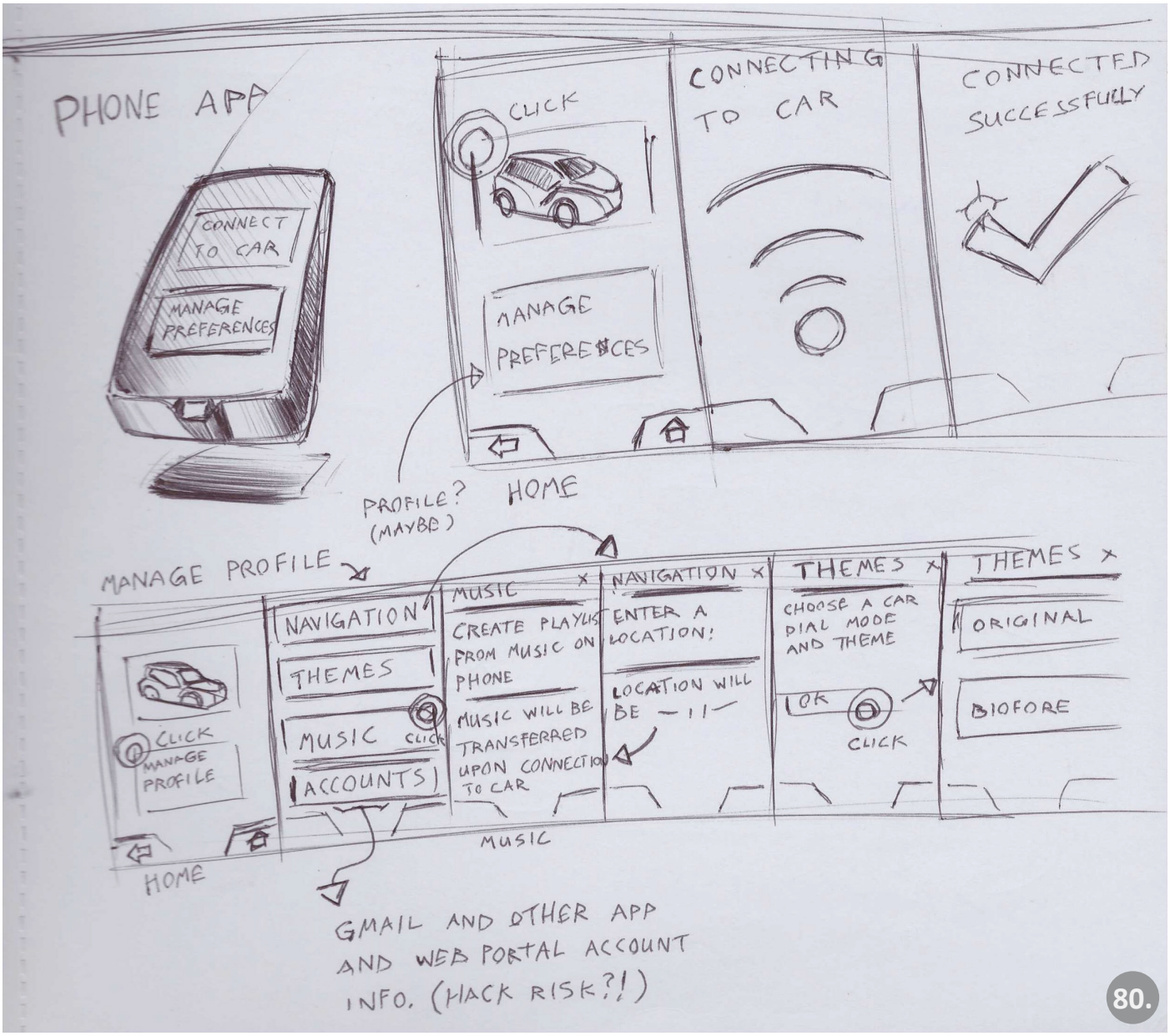
77.

iOS 7
“SIRI”

To my experience at least some of the destinations we want to reach with private or public transportation are first discovered nowhere near a car. When looking for the closest store or for a certain address people no longer need desktop computers or laptops. They can just as well use their smartphones that incorporate to a certain extent the same functions. Especially with smartphones turning the concept of a “cellphone” into a more of a personal assistant than a communications device. With applications like the iOS 7 “SIRI” or the Android AIVC designation: “Alice”; programs that enable you to search for anything from the internet that you can think of by using voice commands. More amazingly you can actually have a “conversation” with those programs, rather than just give them commands.

As more and more people own a smartphone, I thought why not use the smartphone as a part of the concept car’s digital user interface. Picture this scenario; you think of an address that you would like to visit when you get out of work. Just open the Biofore car App and add the address to your profile’s My Locations-folder. As you are walking to your car simply press the connect-to-car button and the application automatically synchronizes the data between your phone and the car. Then all you have to do is go to the Navigator in the IVI and you can find the same address in the cars “My Locations” -folder.

Android
AIVC “Alice”



Thinking of this scenario brought me to an epiphany about how I could make buying the car an exciting experience for the rest of the household, not just for the person who will mainly be driving the car. As you buy the car you get a download link to an application store from where you can download an unlimited amount of the Biofore car apps. This would help businesses buy cars that could be customized to meet driver specific needs and preferences. This applies to normal consumers as well, at some point most nuclear families might contain multiple drivers.

The Biofore phone app could be used to make preselections for the switchable dial layouts, map locations and interior lighting themes. Presetting radio channels through a radio subprogram in the smartphone might also be something that the users would want, since 19 of the 22 survey participants said that they use preset channels in their car's multimedia system. Possibly even music could be transferred from the phone to the car's hard drive.

Most internet browsers ask you if you would like for them store your account information; nicknames and passwords for chosen websites. I thought that it would be a good addition to the Biofore app, to have all of your account information stored in the program. That way every time you went to lets say Facebook via the concept car's browser. The browser would notice that the IVI is connected to your phone and it would automatically retrieve your account information for Facebook and log you in. No more retyping login information.

This however produces a possibility for a security risk. Obviously none of your personal account information would be stored in the car's onboard computer's memory, it would be stored in your smart-phone. I don't know how many people have their smartphones save profile data for websites, but I still feel that I would to some degree be responsible for protecting the user's privacy. Account information transfer between the application and IVI was post poned for the lack of resources.

The selected look for the smartphone application used many of the graphical elements designed for features in the IVI to make the learning process easier. For example, the smartphone application used same buttons as the IVI. All of the menus with which the user could customize what he or she sees in the car were kept similar to those in the IVI, as seen in the pictures of the Interior lighting controls below.

81.

A comparison between the interior lighting controls in the IVI of the car and the GUI in the smartphone application.

See the separate document "Biofore app" for further information about the smartphone application.

One of the core design principles for the Biofore concept car was that, it should become a forerunner for manufacturing road capable vehicles out of more biodegradable and reuseable materials such as the UPM Grada and Formi, also the all-out manufacturing process had to become a more environmentally friendly procedure. I felt that my responsibility as the IVI designer was to bring environmental awareness to the car's users. I had been throwing around ideas of what would be the best way to get the driver's attention, either before, during and, or after driving the car.

82.

Screenshot of UPM's video about the concept car.

I always had driver and passenger safety as my first priority when designing visuals and usability models for the graphical user interface. That brought me to the conclusion, that the safest way to guide the user's driving, was to give him or her trip oriented information after they had turned off the car's engine. I made models of two possible users who would be the exact opposites of each other, one a very environmentally conscious driver and the other not so much. The idea was to automate a notification that would appear on the driver's screen immediately after he or she had turned off the engine. The color and the message of the notification would change based on the driver's actions during the trip he or she drove.

> Scenario 1: The driver did well according to the onboard drive-analyzer. The IVI informs the driver that he or she made a very economical trip. Then gives the possibility to view the trip information, so the driver can see how he did, and where he could do better. The IVI could show the all-out greenness score for the entire trip and the score based on the location of the car during the trip.
>
> Scenario 2: The driver could have done better according to the onboard drive-analyzer. The IVI informs the driver that he or she could have done better and automatically shows the "mistakes" the driver made. Starting from the most critical improvement suggestion, to the least critical. The driver has to go through them all until he or she can see the dials again.

Scenario two might prove to become a danger, if the driver knowingly chooses not to pay attention to the suggestions and keeps on driving without seeing the dials. I thought of a precautionary function, which brings up the dials, for example, at 20 kilometers an hour to minimize unnecessary distraction to the driver. Would the improvement suggestions then be completely useless? I assume that most of the users would go through the improvement suggestions without a problem. In the end the users themselves will decide whether or not to pay attention to what the caution windows are saying.

83. *A commercial picture of the Greenness game.*

Automated notifications are good, but there is a chance that the driver would merely overlook them and keep driving the way he or she always has. I had to figure out a way to make the drivers themselves want to improve their driving. For that I turned to the social media.

One very popular phenomenon is shaping the lives of many these days. That phenomenon is Global warming. Everyone knows that our past high carbon footprint lifestyles are partly to blame for the change in the Earth's climate. People everywhere around the world have made changes to the way they live so our children would one day have the privileges that we have had. To swim in clean waters, to breathe unpolluted air and to live on a green Earth. - That is what the brochure says, for some it is only a way to prop up one's self-esteem and to be better than your neighbors. No matter what, it seems like green is the way to go.

> Researchers found consumers are willing to sacrifice luxury and performance to benefit from the perceived social status that comes from buying a product with a reduced environmental impact. (Vaughan, 2010).

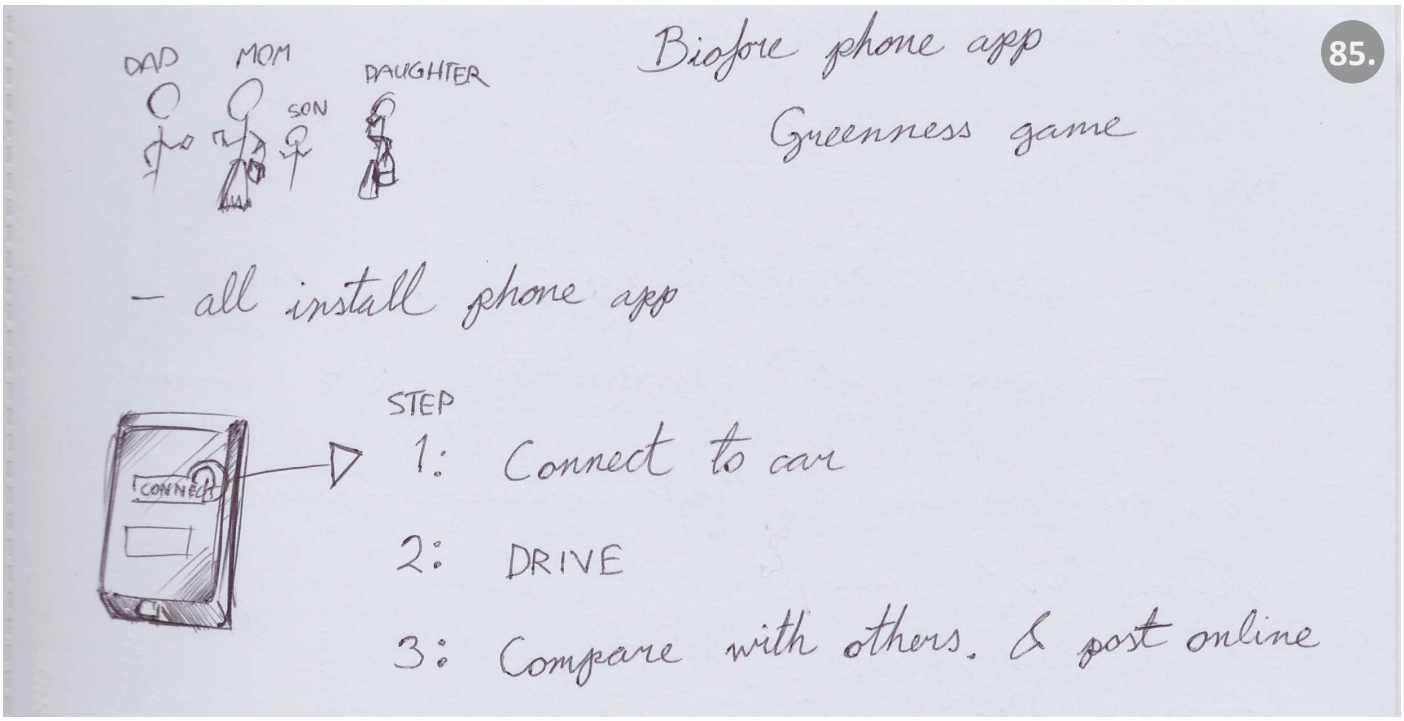
The basis for this statement came from the results of an experiment that 168 students from the University of Minnesota took part in. In short the results were suprising. Within the control group only 37.2% of the participants chose to buy a green car. In the test group 54.5% of the participants chose the green car. (Vaughan, 2010.) The reason for the change was that the test group had read a story about "moving up in the world" and then made their choise. (Corner, 2010).

84. *Screenshot of Stop Global Warming's facebook page.*

> For most people, there is nothing quite as interesting as other people. We are incredibly well at tuned to what others are doing and thinking – especially if they might be thinking about us. The choices we make speak volumes about our likes, our hates, our personalities and our social status. (Corner, 2010).

Social pressure and envy of others seem to be driving forces for basically anything as said by Adam Corner: “people will compete to outdo each other on whatever criteria happen to be around.” (2010).

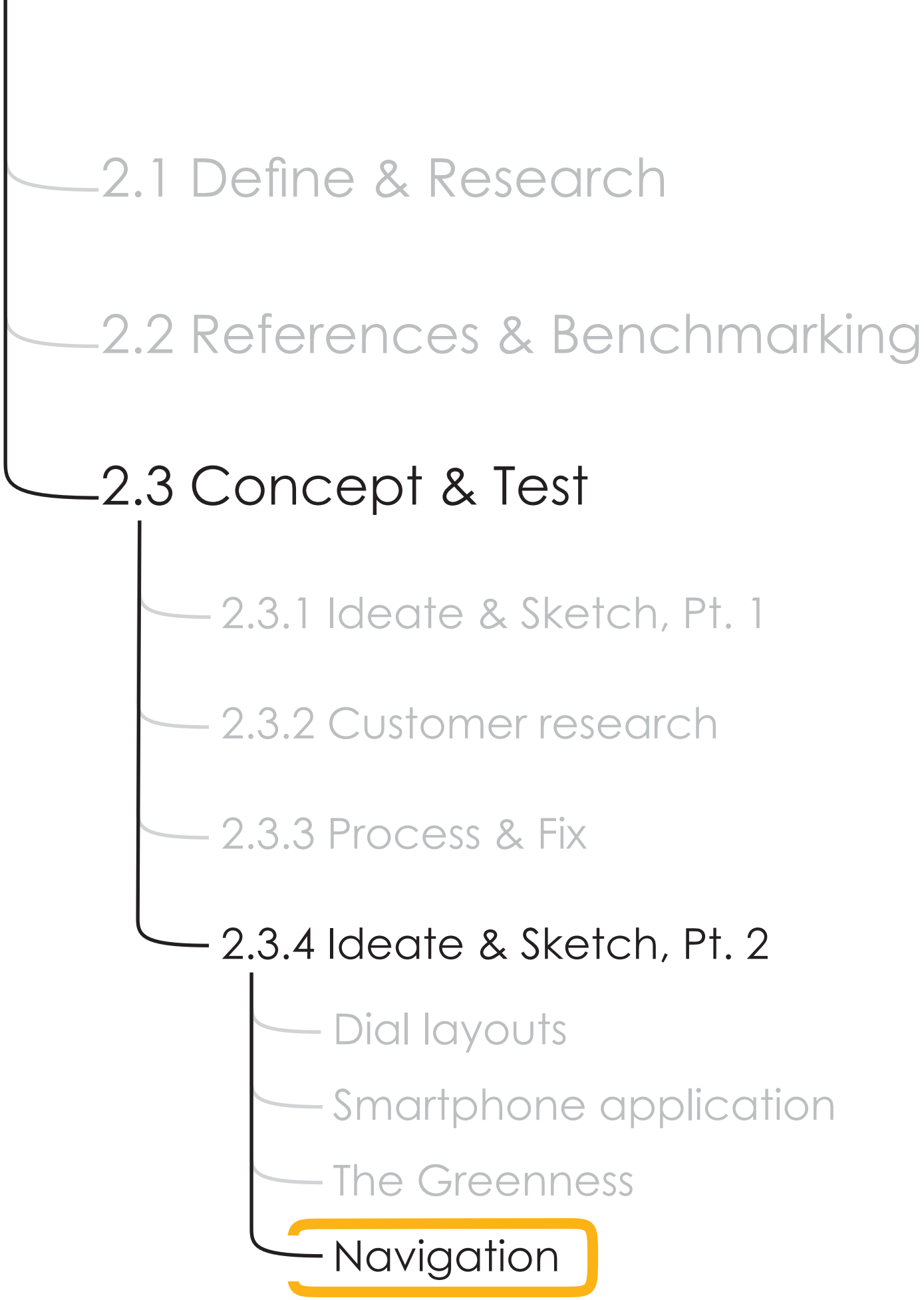
As proven social pressure is an extremely potent force. One clearly visible form of social pressure is seen in social media services. People post on Facebook, Tweet and so on, about the things that they have done during their day or the things they will do, if certain requirements are met. A very popular post is about something good you have done for someone else. Posts that include doing something for the nature are fairly common. Those posts usually get “likes” and are commented by others, saying that they also have done something to help prevent global warming. Social media, being such a great factor in our daily lives might prove to become a good way to get the driver to change his way of driving.



Sketch of the Greenness game.

Because of this information I began designing a new feature for the Biofore smartphone app. That feature would save drive data for the driver. The program would then use that data to calculate all-out driver greenness -score and then show it in the form of a family (driver) tree. That way the people close to the “worst polluter” could hint him or her to change their way of driving. Through the Biofore app, the users who are proud of how well and how green they have been driving could also post their greenness –score to Facebook or other social media services for all of their friends to see.

Unfortunately the graphical design of the “Green meter” and “Greenness game” -functions were postponed due to a pressing timetable to have the concept car ready for the 2014 Geneva motor show.


2.1 Define & Research
2.2 References & Benchmarking
2.3 Concept & Test
2.3.1 Ideate & Sketch, Pt. 1
2.3.2 Customer research
2.3.3 Process & Fix
2.3.4 Ideate & Sketch, Pt. 2
Dial layouts
Smartphone application
The Greenness
Navigation

When driving, it would be extremely nice to know where you are going. What highway to take, which ramp to get off at and even more importantly how to best navigate through crowded cities. I saw the navigation function as a necessity. Not only because of the Greenness game, but because many drivers use navigational devices on a daily basis. Devices such as smartphones and in-vehicle-navigators that are either in the infotainment systems of a car or separately sold navigators (SSN) like TomTom and Garmin. Those who don't own cars that have IVI systems with navigators tend to use smartphones with holding arms or SSN:s that are attached to your windshield.

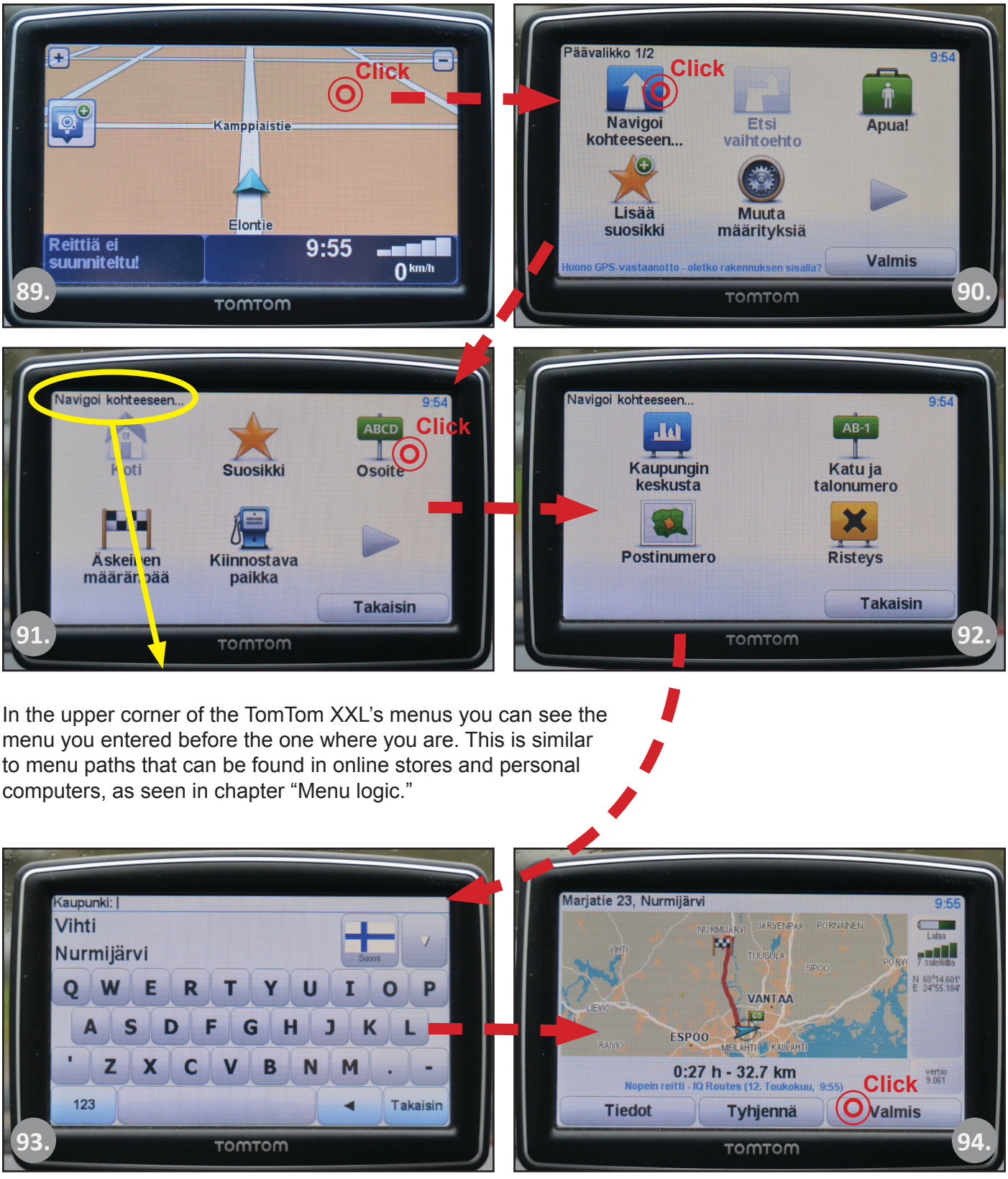
Pictures of different types of in-vehicle-navigators.

The fact that the navigator device is in your immediate field of view while driving a car can be ambiguous. It is a good thing because you don't have to look far to know where the navigator is guiding you next. This means that less reaction and realization time is needed to operate the vehicle safely. It is also a bad thing because the navigator restricts your field of view depending on its size. One of the main reasons why an ordinary rear-view mirror was never designed to be in the concept car was the fact that it unnecessarily restricted the drivers field of view.

A navigator with a small screen obviously takes less space than a navigator with an extra-large sized screen. However a smaller map and smaller guidance icons mean that you have to concentrate more on the screen, you can not just leave it at a peek and keep driving. Even at low speeds everything that makes your attention deviate from concentrating on the road contributes to making mistakes while driving. In some countries SSN devices are illegal in the means that they obstruct your field of view. Therefore attaching a separate navigational device to your windshield is classified as a fineable traffic violation.

Common to all of the navigator types listed above is that when they are turned on, most of them immediately go to a map view and start searching for the users location. If left untouched the navigator's view would just follow you around displaying your location, compass heading and current speed. (In Google Maps the latter two are not shown.) All of the devices I have seen are touch screen operated. Once touched in the map view SSNs usually open a menu from where you could choose what you want to do next, as shown in pictures 89-94.

Flowthrough of TomTom XXL's navigation.

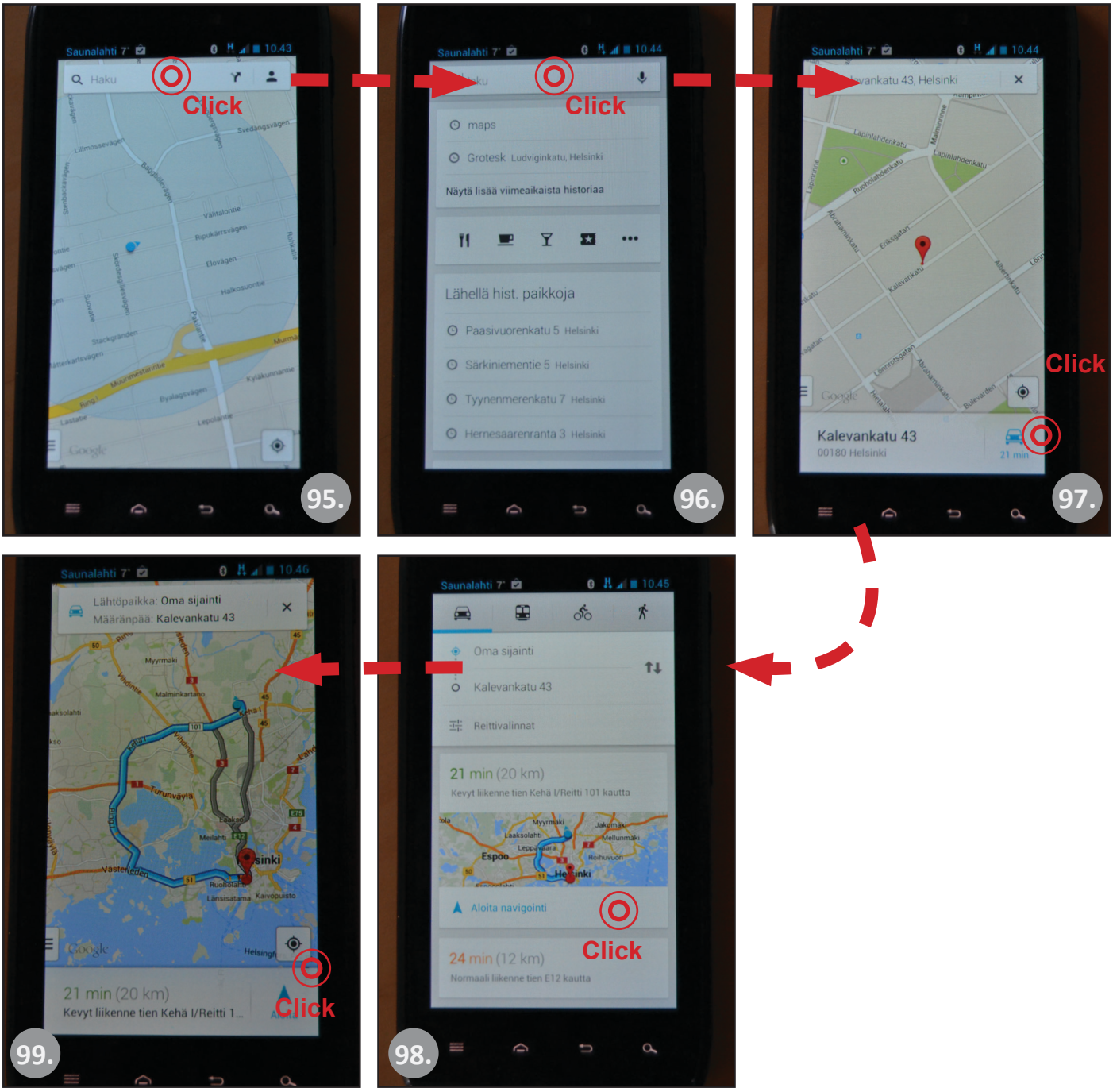


In the upper corner of the TomTom XXL's menus you can see the menu you entered before the one where you are. This is similar to menu paths that can be found in online stores and personal computers, as seen in chapter "Menu logic."

In the TomTom, the user has to first choose a city, then a street and after that a number for the chosen street. After that the device shows the user their itinerary and asks what they want to do next.

In Google maps touching the map view does not open a menu, because the users navigate the map using their finger. To search for a location the user would first have to click on the search bar in the upper corner of the screen. Once the search menu has opened the user can see popular locations near him or her and a small search history. To search for a location the user would have to type in the wanted address, and then press the car -icon. Google Maps would then show the user their itinerary and give an option to begin navigation.

Flowthrough of Google Maps' navigation.



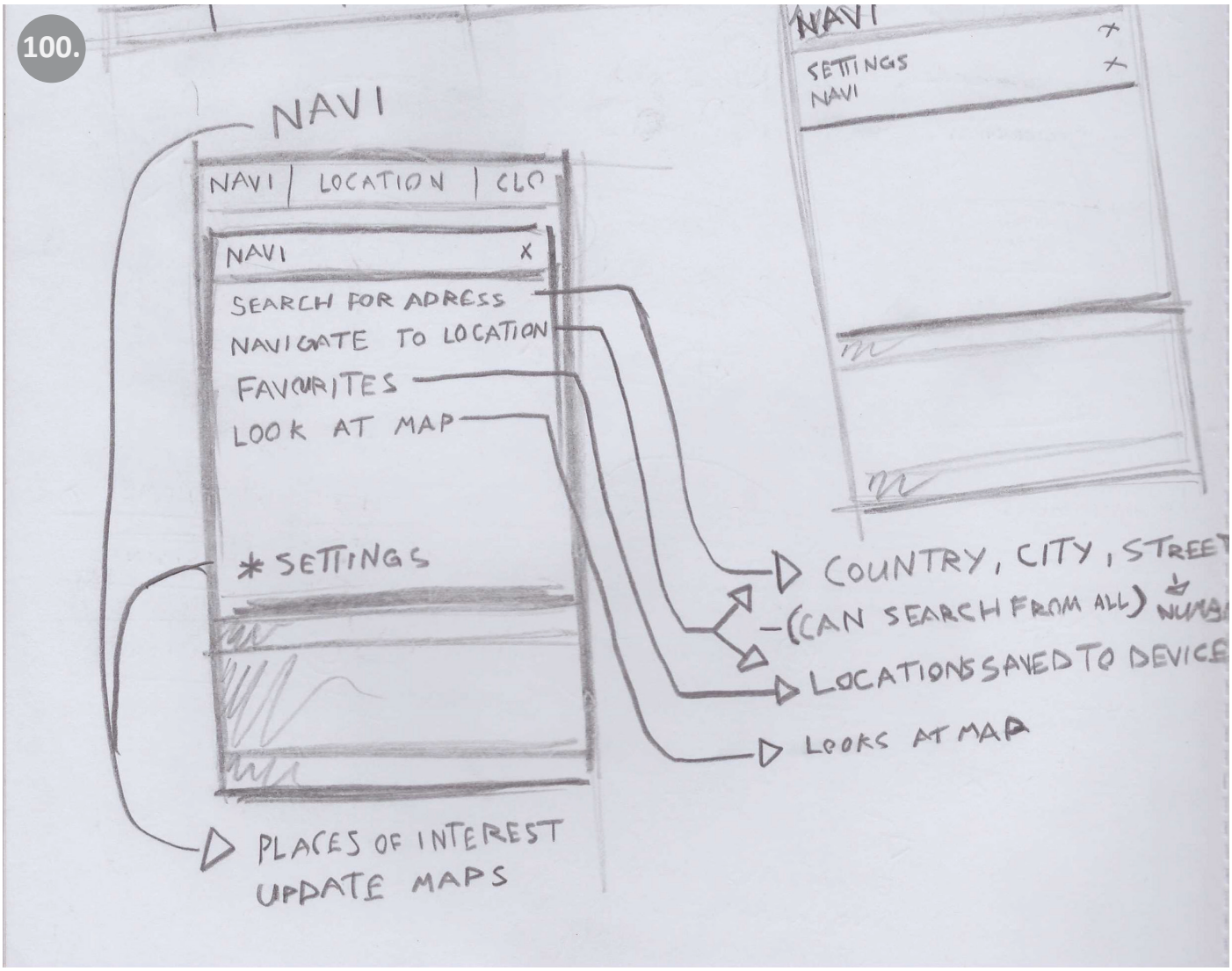
Being a such an important function in the car, the navigation could well have been located into the MAW. There was one very pressing reasons to why it was not. Our car did not have a voice control so the users could not just drive and say "Car, navigate to road x." The users would have to manually input all of the information into the IVIs middle screen. In most cases this meant first typing and then selecting a city, a street, a house number and then pressing navigate.

> The NHTSA has issued guidelines to minimize in-car distractions. A glance at the screen should take only two seconds and an entire task should take up to 12 seconds, for example, and certain actions should not be possible unless the car is parked." (Jeffries, 2014.)

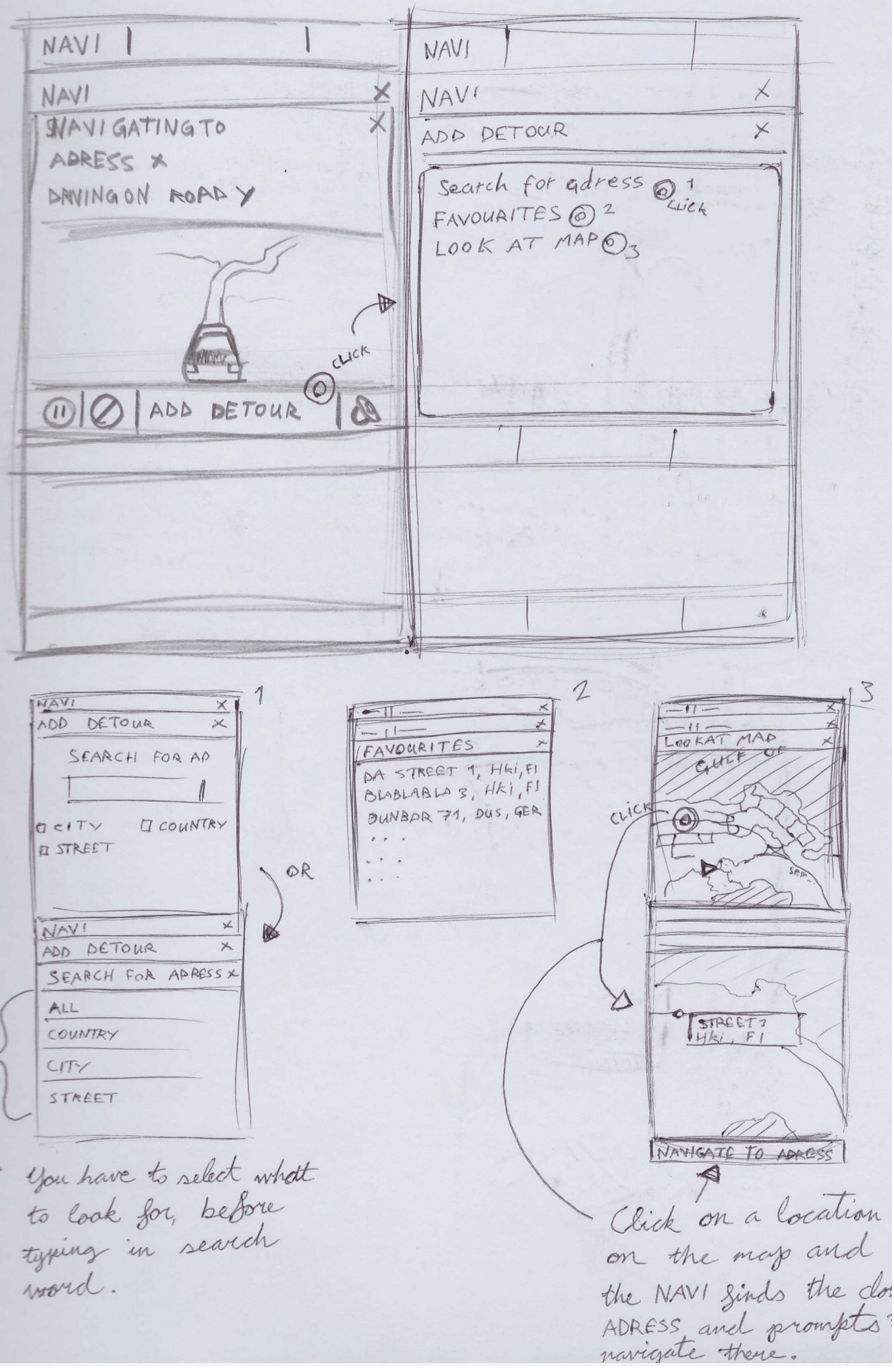
While driving the on screen keyboard was disabled for driver safety. I assumed that typing lenghty words into a touch screen device and then selecting objects would need more dwelling time as a whole than the 12 seconds. The legal regulation for a dwell time was 1.5 seconds per peek and that was indicated by the *EN ISO 15005 Standard*. (2002, 7). Partly because of this the button for navigation was placed into the upper right corner of the IVI middle screen.

In a normal seated position from where the driver would drive the car, the screen was still at a very long distance from him or her. Meaning that if the driver wanted to use an interactive button placed at the top of the screen he or she would have to reach for it. Hopefully the fact that the button was placed so far away from the driver, he or she would refrain from using it while driving. I though of creating a false graphic button affordance for the navi, so while driving the navigation button would look like it could not be pressed. However that could have caused confusion in the driver at an exact moment when he or she sould be concentrating on the road. Should a user press the button for navigation, the navigator itself will open, but as it opens it will inform the driver that all search and writing functions are disabled while the car is moving.

Sketches of how the Navi would work.



101.


NAVI
NAVI
NAVIGATING TO
ADRESS X
DRIVING ON ROAD Y
ADD DETOUR
CLICK
NAVI
NAVI
ADD DETOUR
Search for adress 1
CLICK
FAVOURITES 2
LOOK AT MAP 3
1
NAVI
ADD DETOUR
SEARCH FOR AD
CITY
COUNTRY
STREET
OR
NAVI
ADD DETOUR
SEARCH FOR ADRESS X
ALL
COUNTRY
CITY
STREET
You have to select whot to look for, before typing in search word.
2
FAVOURITES
DA STREET 1, HKi, FI
BLABLABLA 3, HKi, FI
DUNDAR 71, DUS, GER
3
LOOKAT MAP
CLICK
STREET 7
Hki, FI
NAVIGATE TO ADRESS
Click on a location on the map and the NAVI finds the clo
ADRESS and prompts
navigate there.

A flow through of the Navigate to address menu.

3 Conclusions

3. Conclusions

The aim of this thesis was to create an IVI system that connected the driver to his or her car. The IVI also had to have a green element. The way the user was connected to the Biofore concept car was by creating functions for the user that allowed him or her to customize certain parts of the cars IVI. Those things were: dial layouts, interior lighting, favourite map locations, personal radio and playlist memory.

The way a user could control those things was either from the graphical user interface of the car, or through a smartphone application that was designed in the project. The smartphone application made it possible to easily switch the users preferences in the car. It also made saving multiple driver preference set-ups or login details easier, because the users had all the data with them in their smartphones.

The secondary aim was to create a green element to the car's IVI. For that a prototype of a greenness calculator was designed. When a user is driving the car an onboard drive-analyzer keeps a log of the traveled route and the way the user is driving. After turning off the engine of the car the onboard drive-analyzer would calculate how economically the user drove. If the user made a very economical trip then he or she had chance to go through the trip data and possible economical driving improvement suggestions. If the user could have done a better job at economical driving then the IVI would automatically show the user where they could improve.

I did not believe that the drive-analyzer and the improvement suggestions would alone make drivers change their driving habits. A prototype of a greenness game was designed to do that. The user first had to use his or her smartphone to log in to the car and then drive. After driving, a user that had logged in to the car would get the same positive or negative feedback, but they would get something extra as well. After the improvement suggestions the IVI of the car would show an all out driver greenness -score. The greenness -score would be calculated from the drivers latest 20 to 30 trips. Once the user had left the car, the greenness -score and the information from the last 20 to 30 trips could be found on his or her smartphone.

A user who was proud of their greenness score could, for example post it into his or her facebook or twitter wall for all their friends to see. The IVI would also show the greenness score for all others who use the same car. That way the people driving one car would subconsciously -or consciously compete each other on who is the greenest driver.

I wanted to present IVI usability test results in the thesis. After all, integration and beta-testing was included in my process, concept and test plan. (See page 30.) The usability test results would also have given value to the ten key pointers to designing GUIs listed on page 21. Unfortunately because of the deadline to finish the car, we did not have enough time to program all of the designed functions. Therefore they were not tested at the time. In the future, maybe even during the summer of 2014, the designed IVI will be usability tested and from the test results I will create a plan to correct possible flaws in the design.

I would say that I met the primary aim of the thesis with the smartphone application. After all it allowed users to individualize what they see in the car to a certain extent. Even after the users had left their car they would still be carrying a part of it in their pocket, thus making the users feel connected to their car.

The secondary aim was to create a green element to the car's IVI. A prototype of a greenness game was designed. However because of the fast approaching deadline to finish the car for the 2014 Geneva motor show, we did not have enough time to develop it to become a feature found in the concept car.

The Biofore concept car is to be registered for road legal use in Finland by the end of the year 2014. The greenness game development will also continue during that time.

4 References

2.1 Define & Research

2.2 References & Benchmarking

4. References

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39. A digital image of how the desktop would work.

40. Sketches of the fixed controls.

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50. Player "main" menu

51. The Radio.

52. A sketch of how the Dial looks and the interior lighting could be controlled.

53. Themes & Colors menu.

54. Themes & Colors, Dial theme selection menu.

55-58. Classifications of the Dial and Interior lighting combinations.

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60-64. Sketches of the dials.

65. Dial options for the customer research.

66. A picture of the customer research.

67. Dial & rearview mirror placement (Chart)

68. Function used in multimedia system. (Chart)

69. The five elements that build a dial layout.

70. How the dials show a warning signal.

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102-106. A flow through of the Navigate to address menu.

Kysely auton käytöstä

Tämän kyselyn tulokset tulevat vaikuttamaan Biofore konseptiauton käyttöliittymän ulkonäköön ja sisältöön. Totuudenmukaiset ja tarkat vastaukset auttavat meitä tekemään käyttöliittymästä helppokäyttöisen ja visuaalisesti miellyttävän.

1. Minkä ikäinen olet? (Rastita sinulle oikea vaihtoehto.)

☐ 18-20	☐ 31-40	☐ 51-60
☐ 21-30	☐ 41-50	☐ 61-70

2. Mihin ammattiluokkaan kuulut?

3. Mitä ajokorttiluokkia saat ajaa?

☐ M	☐ A	☐ C1	☐ D1	☐ BE	☐ CE	☐ CE	☐ DE
☐ T	☐ B	☐ C	☐ D	☐ C1E	☐ D1E	☐ D1E	

4. Mitä autoa ajat? (Mikäli, et omista autoa, niin mitä autoa olet ajanut paljon?)
(Vuosimalli on myös hyvä mainita.)

Jatkuu seuraavalla sivulla.

5. Mitä ominaisuuksia käytät autosi äänentoisto-/ multimediajärjestelmässä?

- ☐ Play / Pause
- ☐ Stop
- ☐ Kelaus
- ☐ Kappaleenvaihto
- ☐ Taajuuskorjain (Equalizer)
- ☐ Repeat
- ☐ Kappaleiden sekoitus
- ☐ Radiotaajuuden etsin
- ☐ Äänen lisätulo (AUX)
- ☐ Bluetooth-äänentoisto
- ☐ Bluetooth-puhelinyhteys
- ☐ USB lisätulo
- ☐ Sisäisen kovalevyn hallinta
- ☐ Puhelinsovellusten hallinta
- ☐ Kanavien pikavalinta

☐ Muita, mitä? _____

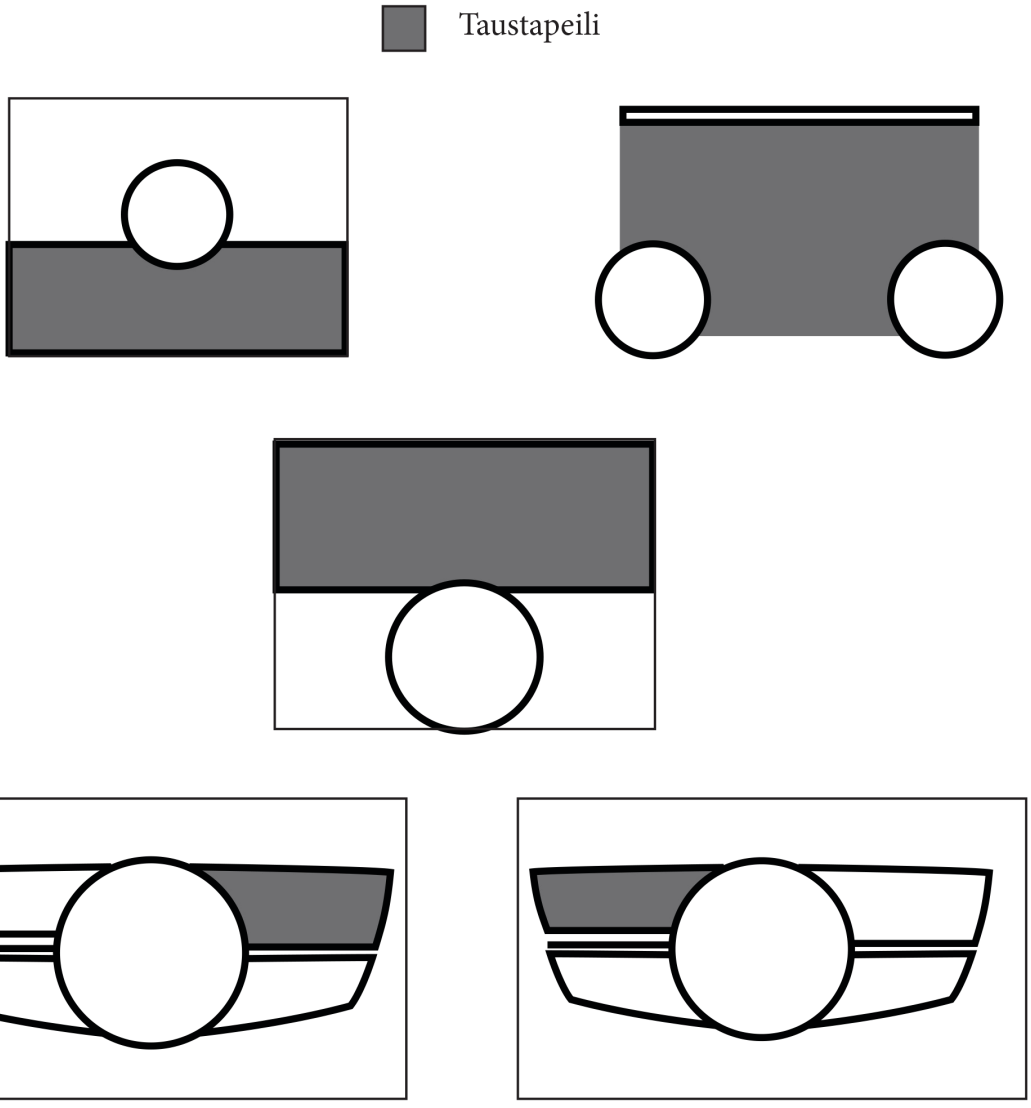
6. Katseletko autosi ajotietokoneen sisältöä...

- ☐ En koskaan
- ☐ Harvoin
- ☐ Joskus
- ☐ Päivittäin
- ☐ Useita kertoja päivässä
- ☐ Muu, milloin? _____
- ☐ Autossani ei ole ajotietokonetta. (Siirry seuraavaan tehtävään.)

7. Mitä asioita autoa koskien, tai muuten haluaisit tietää, kun ajat autoa?

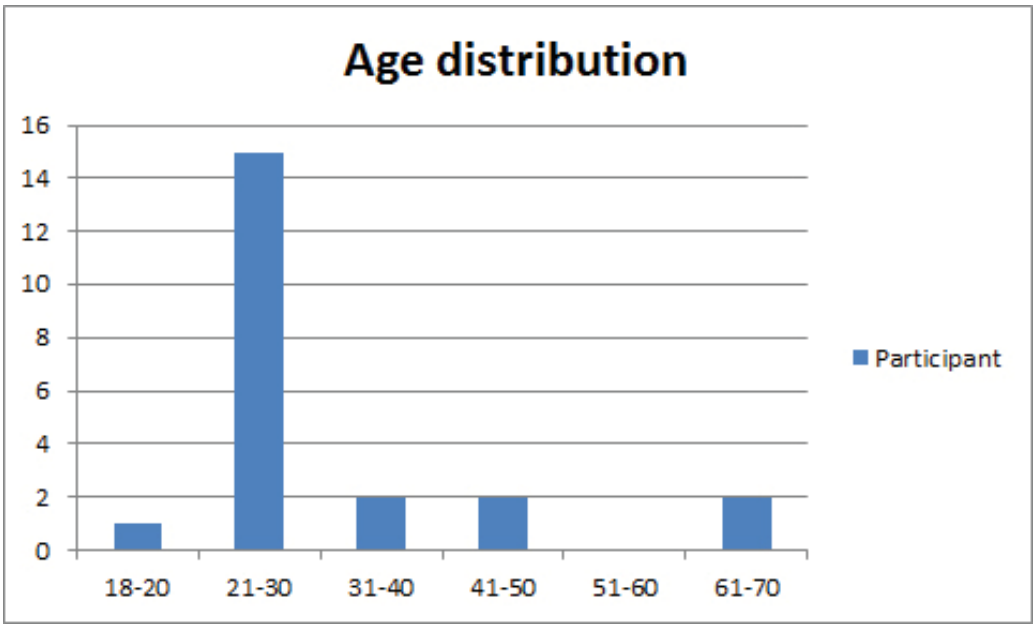
Jatkuu seuraavalla sivulla.

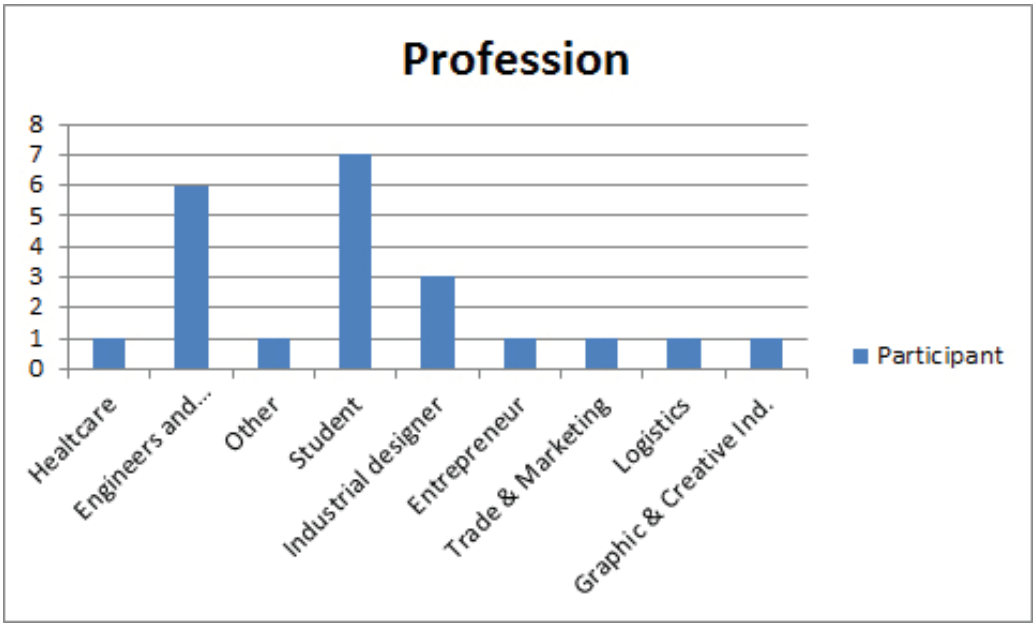
8. Kuvittele tilanne, jossa ajoneuvon taustapeilin kuvaa joutuu katsomaan näytöstä, joka sijaitsee auton mittariston kohdalla alla esitetyillä tavoilla. Ympyröi mielestäsi paras vaihtoehto.

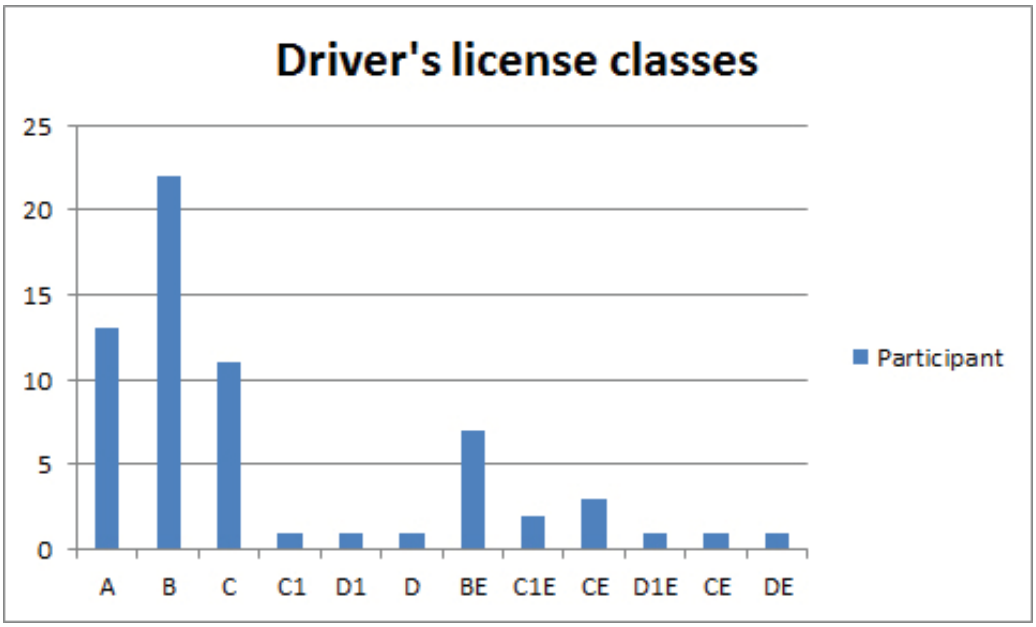


Kiitos ajastasi,
Oikein hyvää päivän jatkoa!

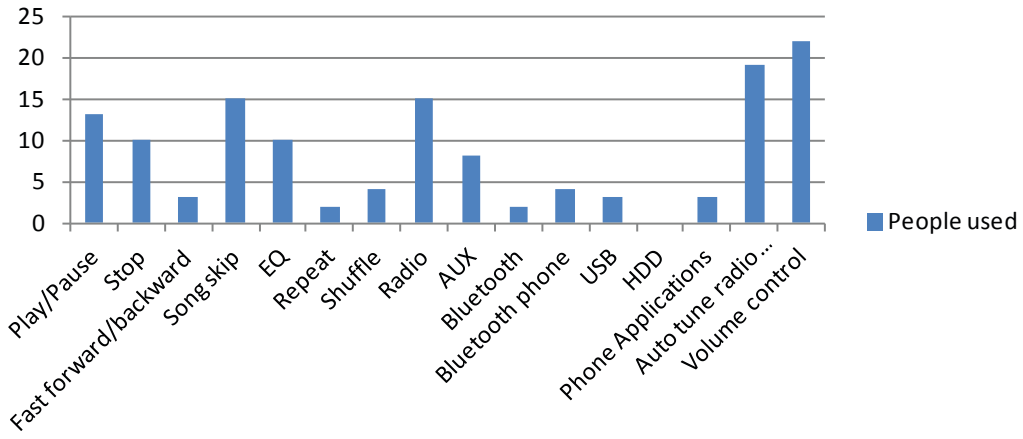
The results of the survey.

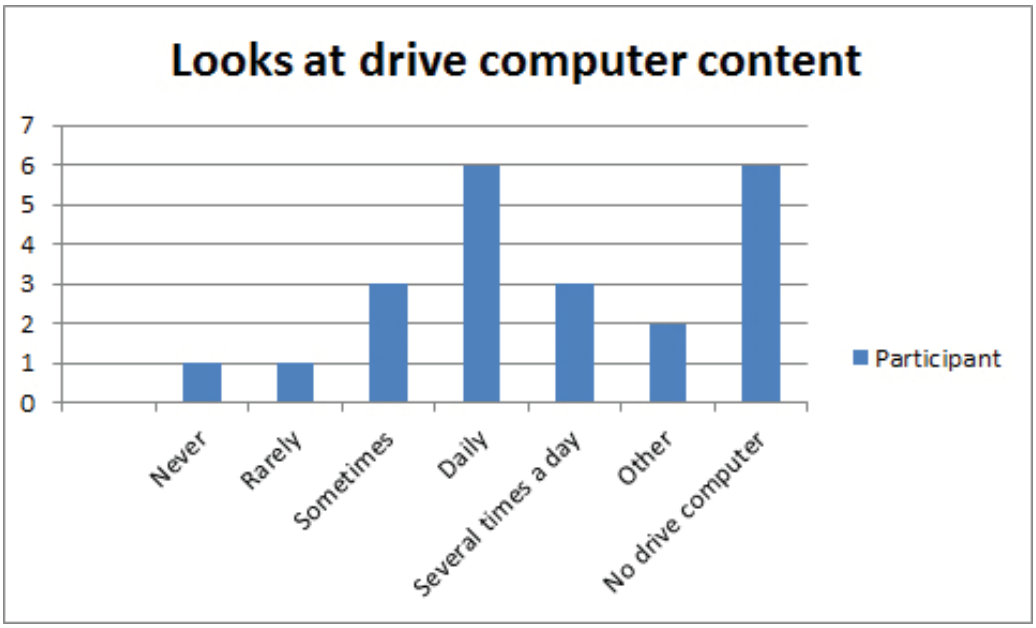






Function used in multimedia system





Dial & rearview mirror placement