Ippocrate

a new steering wheel monitoring system

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INDEX

1. Abstract Page 9

2. History and evolution of the steering wheel Page 10

2.1 Before the mass production of the automobile Page 12
2.2 Industrial automotive production: Henry Ford Page 13
2.2.1 Ford Mustang Page 14
2.3 Others fields Page 22
2.3.1 Formula1 Page 23
2.3.2 Rally Page 25
2.3.3 Cinema Inspirations Page 27
2.4 Modern times Page 30
2.4.1 Remote controls and features Page 31
2.4.2 Steering Wheels fo disables Page 32
2.4.3 Material innovation Page 35

3. The driver Page 38
3.1 Needs Page 40
3.1.1 Safety Page 46
3.1.2 Flexibility Page 48
3.2 What happens when a person drives Page 50
3.3 Human factor Page 53

4. The context Page 56
4.1 The environment Page 58
4.2 Vehicles Page 61
4.2.1 Smart vehicles Page 64
4.2.2 Smart Objects Page 66
4.3 The man and the computer Page 69
4.3.1 Limit the features Page 70
4.3.2 Stimuli and elaboration process Page 72
4.3.3 Risk and danger Page 75

5. Concept Page 78
5.1 Purpose of the project Page 80
5.2 Monitoring the driver or the drive? Page 84
5.3 Vital parameter Page 86
5.3.1 Temperature fluctuation (fever or hypothermia) Page 87
5.3.2 Fickle Pressure (hypertension or hypotension) Page 88
5.3.3 Heartbeating ratio (bradycardia or tachycardia) Page 89
5.3.4 Eyes tracking Page 90
5.3.5 Issues due to old age Page 91
5.4 Interaction Design Page 92

6. The Project: IPPOCRATE Page 96
6.1 The name and the Logo Page 98
6.2 The Functions and the Targets Page 102
6.3 The shape Page 104
6.3.1 Grabbing parts Page 106
6.3.2 Central Parts Page 108
6.3.3 On-wheel commands Page 110
6.3.4 Sensors position Page 112
6.4 Sensors Page 114
6.5 Eyes movement detection cameras Page 116
6.6 Resistive touch screen Page 118
6.7 The materials and Stress Tests Page 120

7. App Page 134
7.1 Tree's organization Page 136
7.2 Style Page 138
7.3 Icons and colors Page 142
7.4 Wireframe Page 144

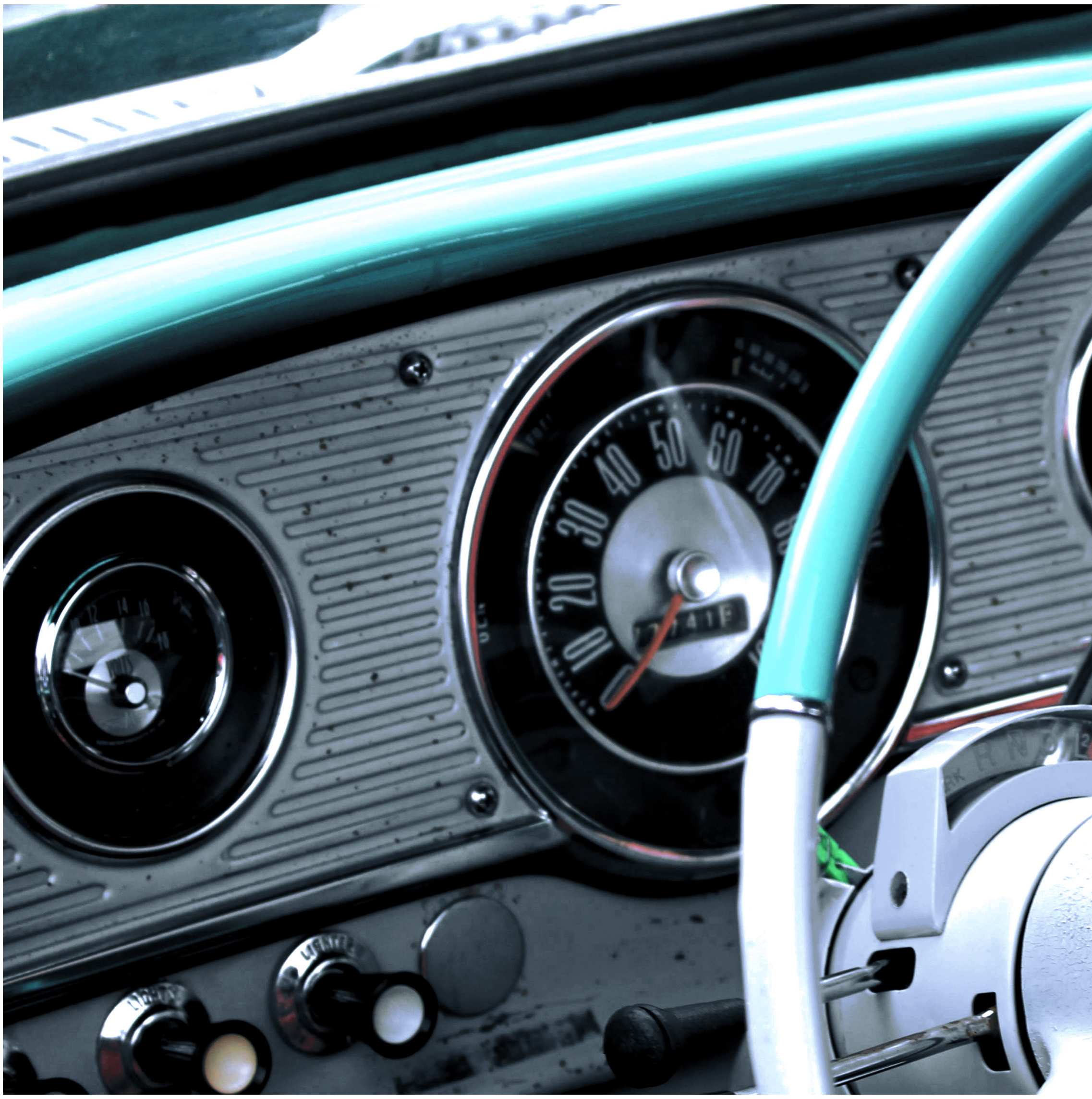
8. Storyboard and examples Page 146

10. Bibliography Page 156

1. ABSTRACT

This thesis project has the purpose to develop a new type of product for driving. The starting point will be analyse the history of the Steering Wheel as an industrial product, then focus on the driver, a person with big responsibilities and a lot of features and tools to control. I will analyse the driver as a person and a processor, in order to quantify the amount of datas it could manage. The next step will be match the target and the environment and to proceed with the explanation of all the parameters i took in consideration for Ippocrate, a new Steering Wheel System whose aim is to help people and let them feel safe .during the driving

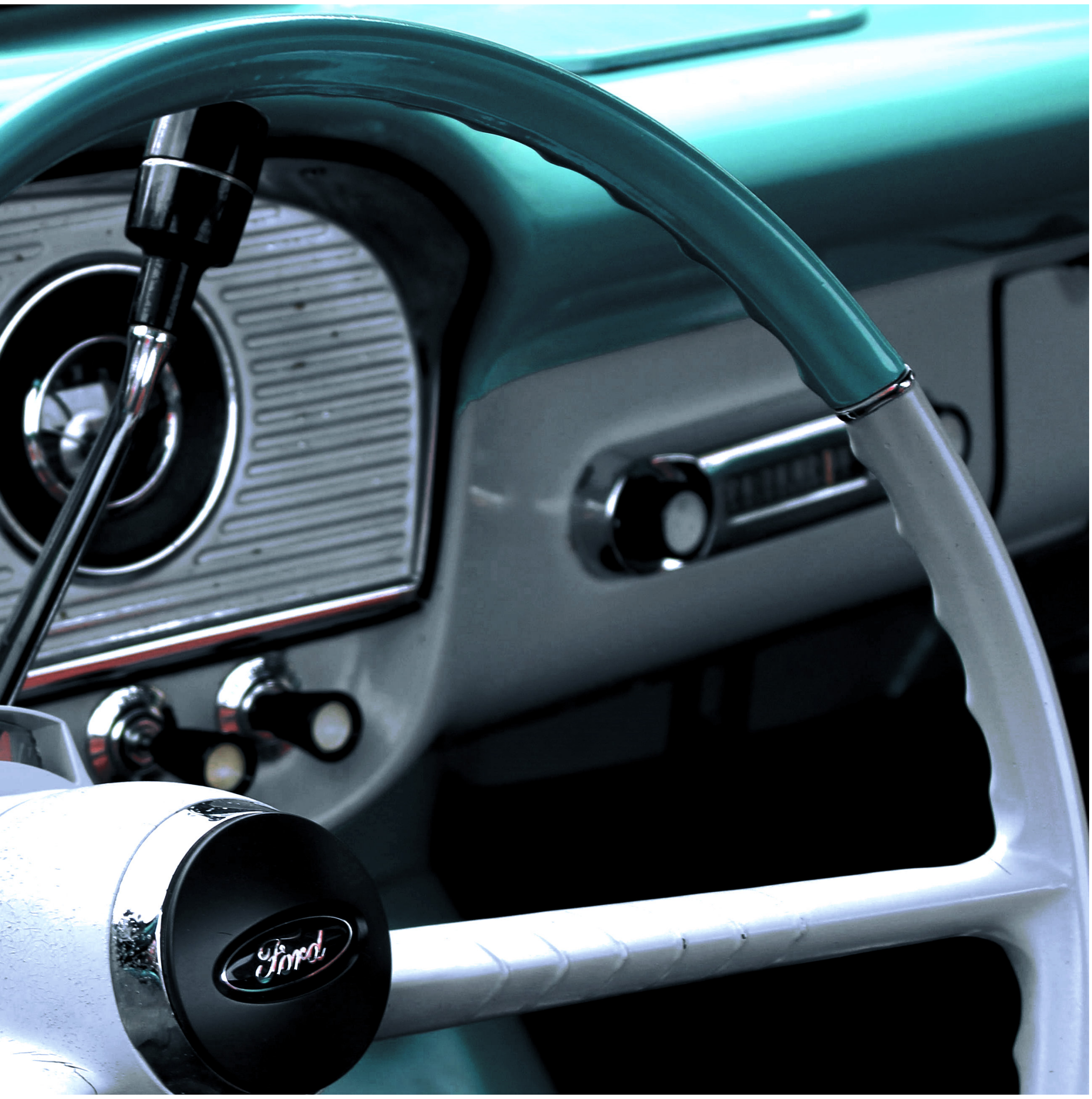
1. Ford Buick Coupe (1940)



2. History and evolution of the steering wheel

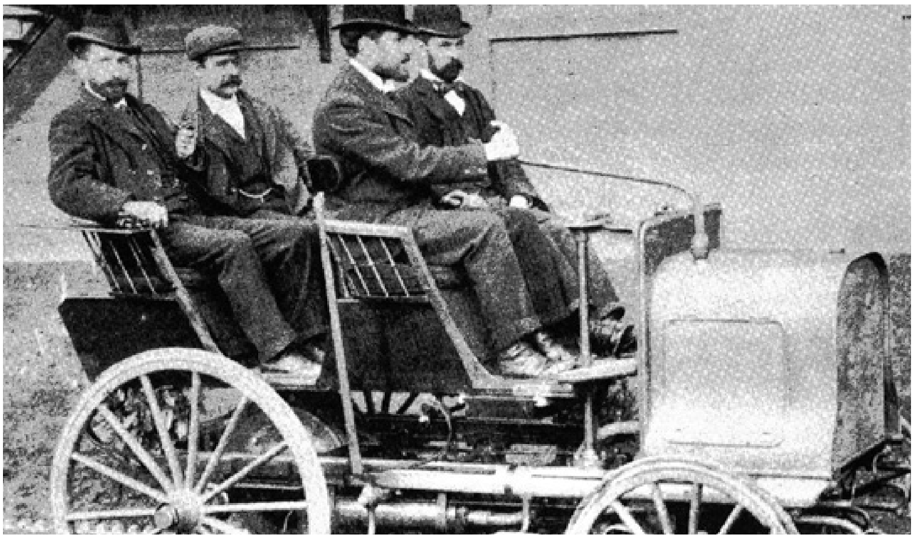
When we talk about control we think of a system, or attitude, that allow us to manipulate something with accuracy. The more is important or dangerous the thing we are manipulating, the more control we need.
A steering wheel is a control system that allow a driver to manipulate, with a certain accuracy, an autovehicle's direction.

The steering wheel was born with the first motorized autovehicle in order to give to the driver a tool to control it. Before the arrival of cars the only system was the cab, and that was governed by rains to give the direction of left and right, and also to stop the vehicle. In a car the driver used the steering wheel just for directioning with no



stop functions, it was a simple tool so it had a simple shape. However that shape became archetypal, its semplicity but recognizability grated to the steering wheel to be an object capable of be a symbol, to be beautiful and comfortable, but also to give the driver the perception of safety that is requested to a vehicle control system.

It's important to tell something about its history because the object itself has run across the whole modern industrial revolution together with the car industry and thanks to serialization and mechanization. The object reflects many industrial techniques de to its evolution in the decades.



2. Daimler's first car photographed outside Motor Mills (1896)

3. Tiller detail from Goletta Pandora (1991)

2.1 Before the mass production of the automobile

The Steering wheel was born with the invention of the modern cars. Before the actual shape it has travel across many different solutions.
The very first "direction system" was actually a tiller[1], very similar to actual joystick or rudder from boats. It was just in the late nineteenth century, in 1893 precisely, in Alfred Vacheron's race that the round shape of steering wheels appeared. That design became after Alfred wide popular. The necessicy of a wheel instead of a tiller was quite comprehensible. The tiller could be turned just of 180 degrees, a steering wheel could provide a wider range of turning. In a world that was becaming more complex and intricate a wheel could be more flexible to new types of driving, streets and cities organization.
Arthur Constantin Krebs was one of the first to replace, in 1898, the

[1] Note referenced to the article "Reinvent The Wheel – A Nonstandard Look at Standards", By John Greathouse – November 25, 2008

tiller with a wheel for a car by Panhard during the race Paris-Amsterdam-Paris. Krebs has been a pioneer in the automotive engineering fields taking a lot of his knowledge from boating industries he worked with.
Around the early 1900s[2] almost every car was equipped with a steering wheel instead of the tiller. At that time the steering wheel was a simple ring usually with two or three spokes, made of wood and occasionally with metals inserts.

4. The world's first automobile race (July 22, 1894).
The photo shows the car of Alfred Vacheron

During this period the production of cars, and steering wheel, was crafts and handmade, each peace was unique and expensive like the cars themselves. Customization was important for the producer, to make their products recognizable, but also for the users as a status symbol of prosperity and value. The customization was not yet focused on the steering wheel because it was perceived as just a tool useful to control the vehicle and not as something important at all.

2.2 Industrial automotive production: Henry Ford

"Economic activity concerned with the processing of raw materials and manufacture of goods in factories"[3]

Bibliographic Notes

[2] Referenced to the site "www.carhistory4u.com"

[3] Dictionary definition from online database "www.oxforddictionaries.com"

When we refer to something industrial we are talking about a product or a system developed in industries, with the top avaiable technologies and with an organization that follow the principles of industrial production. The settings of the industrial work were founded by Frederick Winslow Taylor and Henry Ford.
Taylor was convinced that the *only best way* to organize the work of the industries was to set up the process in a rational way.

Henry Ford took Taylor's proposals and applyied them in the fields of automotive industry founded by him inventing the Assembly line. With this method Ford was able to build his company and to make the autovehicles democratics, when they were just for wealthy people before.
Therefore with fordism we mean[4] industrial process that follow Taylor's principles and some kind of automation and mechanization of work in the industry itself.
Henry Ford change the way to approach not just to the industry, not just to the car's fields in the mass production system but also to details. It' important in this thesis to focus on details, because a Steering Wheel is a simple object, made of few parts, but grown up focusing on details, on processes, on material selection, concept and functioning.

Following the evolution of one of the most famous car in the history, the Ford Mustang, is a good example of how the steering wheel evolved during this century[5].

2.2.1 Ford Mustang

In 1964, when Ford introduced its muscle car - Mustang - it didn't

[4] From the Dictionary of Social Sciences, by Paolo Jedlowski, William Outhwaite - 1997

[5] From the official video by Ford Media about Mustang's Steering Wheel evolution, on www.youtube.com/watch?v=khQtsJSH32M

5. Ford Mustang (1964)

just launch a car. It launched a whole new class of cars (the Pony Car segment) an affordable, compact, highly styled car with a sporty or performance-oriented image. Since its launch, the Ford Mustang has become an icon in the Pony car segment and has had the privilege of being the favourite cars of numerous famous (and infamous) personalities. If you are a cinema buff, you cannot miss the Mustang in old movies as well as period movies. Ford Mustang has been creating and influencing trends in the automobile industry so it's interesting to focus a little bit on the evolution of its steering wheel.

The Ford Mustang's steering wheel, in 1964, was shaped in a wheel with three spokes. The ring was made by Stainless Steel glossy painted (usually in light blue), the spokes were Stainless Steel polished showing a beautiful contrast and separating the parts. The central part of the

Bibliographic Notes

6. *Ford Mustang, two spokes leather steering wheel (1974)*

Steering Wheel was roundy, made separately and fixed on the assembly, with the logo in the center of the wheel. There was something like technical ostentation in it, the desire to show a beautiful object made with high-level technologies, featuring industrial finishing (the polished metal, the holes on the spokes).

In 1968 Ford introduced a collapsible steering column and a stabilizig bar on the wheel. Before this introdaction the impact of an ipothetic accident was distributed directely to the driver towards the steering wheel, with no absorption. The collapsible column, as you can see in the following page, was made to decrease the impact on the driver and take it in elastic way. Safety during driving, in the early 1970s, was becoming very important.

7. Ford Mustang, four spokes leather steering wheel with incorporated controls (1979)

In 1974[6] was launched by Ford a new Mustang's Steering Wheel, covered in leather, with two spokes. Mustang introduced available power rack-and-pinion steering, reducing the size of the steering wheel to 15 inch in diameter as opposed to the standard 16 inch one. It's worth noticing that Ford was a lot interested in finishing, materials and the whole design aspects in those years, as all the other companies.

Later in 1979 the Fox Body Mustang came with some European influence

[6] From the article "Ford Mustang: Steering (Wheel) the Automobile Evolution" written by WheelRush Team, September 18 2015

8. Ford Mustang SVO, plastic finishing (1984)

in its design. The two-spoke wheel from the previous Mustang was replaced with a four-spoke wheel, which was later adopted by other Ford vehicles. Wiper and light controls moved to a steering column stalk. It was the first time a steering wheel had incorporated vehicle controls.
In 1984 the Mustang got more muscle with the legendary Special Vehicle Operations Mustang (Mustang SVO). SVO Mustang included a tilting three-spoke steering wheel featuring a thicker rim and smaller outside diameter for a sportier look and feel. The materials were less elegant and more tech-style, everything was made with polymers.

In 1990, the Mustang was equipped with safety airbag and ateering wheel controls. The airbag was located in the center of the steering wheel. So, the horn control found their place on the two spoke-

9. Ford Mustang's first air-bag steering wheel (1984)

Bibliographic Notes

mounted buttons, accessible by the driver's thumbs. The look was less refined, more generic-style in comparison with the others from previous years that were heavily recognizable.

1994 was the year when the fourth generation Mustang was launched, with a twin cockpit layout like the first Mustang. The steering wheel now flaunted many vehicle control buttons for easy and intuitive access by the driver. Horn buttons were replaced with a hinged airbag cover that double as horn control at the wheel's center. The generic style go back to a refined, elegant leather steering wheel, suitable with a famous brand like Ford.

Fashion keeps repeating itself, even for cars. The three-spoke wheel reappeared on the fifth-generation Mustang in 2005. This wheel

10. Fourth generation of Ford Mustang (1994)

11. Fifth generation of Ford Mustang, aluminium version steering wheel (2005)

Bibliographic Notes

12. Ford Mustang Steering Wheel last generations (2013)

was available with standard urethane spokes, or optional aluminum spokes. The controls on the steering wheel are essentials, as it is the shape itself made just by the intersections of circles and lines. It's the age of minimalism.

With the empowerment of technology, the Mustang got many more buttons added, including volume, phone, audio input selections and radio station selectors. The Mustang steering wheel continued as the center for vehicle controls.
In the 50th anniversary Mustang, up to 20 buttons can be found on the steering wheel. It trimmed its diameter to 14 inches. The aluminum spokes are trimmed back from the rim so the driver’s hands only touch leather when holding the wheel.

13. Ford Mustang Steering Wheel last generations (2015)

14. Ford Mustang GT350-R (2015)

Bibliographic Notes

15. Formula 1 Steering Wheel from McLaren vehicle (2015)

2.3 Other fields

The field of automotive is a kind of weird. Is enough technological to require a certain amount of research and testing but not enough to move the know-how of other fields. Many technical solutions that we use nowadays are mutuated from different applications: the ABS system for example was born for racing car and military applications (during the landing fase of planes).
For this reasons the automotive applications are very related to different other fields. I will briefly focus on some main fields in order to evaluate wich are the most important relationship between the evolution of the steering wheel for cars and from where the know-how it was coming.

2.3.1 Formula 1

The modern Formula 1 car is among the most technological machines ever made. Every task a driver might need to do, every bit of information he might need to know, is quite literally at his fingertips. The modern Formula 1 steering wheel is, therefore, the most amazing steering wheel ever made. It is, in every way, the nerve center of the car.

That's because an F1 car has dozens of parameters that can be adjusted on the fly, but only by the driver. Although telemetry provides a nonstop stream of data to engineers on the pitwall and at team HQ, the driver has sole control over things like differential settings, the air-fuel mix, and the torque curve. All of these settings can change several times during a race, or even a lap. Adjustments must be made while keeping

Bibliographic Notes

16. LCD screen on the new Sauber's team steering wheel (2015)

both hands on the wheel and both eyes on the track, which is why a modern F1 wheel might have 35 or more knobs, buttons and switches flanking a small LCD screen introduced in 2015. Drivers also use small paddles behind the wheel to shift up and down as many as 4,000 times in a race, and a third paddle to engage the clutch.

The PCU-8D LCD screen, made by McLaren Electronics, is 4.3 inches wide with a resolution of 480 x 272 pixels. It can display as many as 100 pages of info and the data can be configured by the driver or his engineer. This year marks a transition to the new technology, with some teams–including Infiniti Red Bull Racing–sticking with the older, simpler, PCU-6D for one more season[7].
More information isn't always a good thing, which is why most teams let each driver decide which wheel they prefer, the older style with

[7] From the article entitled "An Inside Look at the Insanely Complex Formula 1 Steering Wheel" written on Wired.com by Jordan Golson, May 2014

the simpler display or the new wheel with the LCD. That said, the LCD screens have a distinct advantage, in that the driver knows exactly that's going on, something that saved Nico Rosberg's bacon when his car's telemetry system failed just before the race in China. With no information from the car, engineers had to ask Rosberg for periodic updates on fuel consumption and other information. The Mercedes AMG Petronas driver eventually grew annoyed by the repeated queries and asked his engineers to kindly shut up and let him get on with the business at hand, taking second place behind teammate Lewis Hamilton.

This explain quite well how far could go the partnership between racing tools and standard ones. Thinking about the many controller we have nowadays on our steering wheel, in almost every car from the cheapest to the more expensive, it come quickly the idea that those feature were inspired by Formula1's. The LCD screen itself, introduced this year on Formula1's steering wheel, could be a good expample of futuristic project, and actually Ippocrate (the thesis you are reading about) has an LCD screen directly inspired by the ones you just read about.

2.3.2 Rally

Racing applications for steering wheel are some of the more interesting to investigate where some solutions come from. Not all of them are focused on the electronics as he Formula1 one.

In Rally competition the most important thing is the control of the vehicle, its stability, its weight and the sensibility of the driver. On a Rally steering wheel there's basically no electronics, of course there is not the airbag, no controls on the wheel, there is just its pure shape as

Bibliographic Notes

17. Sparco composite steering wheel from Hyundai (2013)

if it would come by 60s. This approach is completely the opposite of a Formula1 steering wheel.
It's important to focus in this case on the materials and a little on the shape too.
Speaking about sensibility in rally's field of application is very common the material kown as "suede", a leather-like material, all natural and very similar to buckskin. The main body of the steering wheel is made by alloy, tipically aluminium bounded with magnesium, or composites material like carbon fiber.
The shape also differs from Formula1, in this case the steering wheel is most of the times circular, in order to guarantee a full control during 180° curves and to let the wheel slip trough your hands after a curve. This controller slipping is avoided during fast curves also using the suede material to increase the friction and avoid slides.

2.3.3 Cinema Inspirations

In the social immaginary the films adaption have an important role, they are able to set up new kind of inspirations and to see through the future. Try to think of what was able to do *Star Wars* by George Lucas with the use of technological and interactive objects, or the suggestions was able to provoke *2001: Space Odyssey* by Stanley Kubrick in the application of artificial intelligence. Movie Making it's not just story-telling, is also a matter of what is imaginable by human being and what is ready to be accomplish.
Speaking about interaction between cinema and reality, there's for sure a big imaginary around cars.

18. From the TV Series "Knight Rider" (1982-1986)

When we think about cars in media adaption its natural to think about *Knight Rider*, a hugely famous TV Series from 80s. This series tell us about Michael Knight (played by that David Hasselhoff from Baywatch), driver of the iconic supercar KITT. In the design aspects of KITT we can see a deeply attention to it's interiors, they shoud be modern, technological, they should reflects why KITT is so special and advanced. For these reasons its steering wheel it's not classic and even less ordinary, is more similar to a joypad, or a plane's cloche. The design choices of the steering wheel were important to set up the parameters they wanted us to perceive, a technological car with misterious functions.
The same process occurred during the designing of all the Batmobile we saw during years in Batman's movies, from Tim Burton's versions to Christopher Nolan's.

19. From Tim Burton's "Batman Returns" (1992)

But technology is not always the leitmotiv, as proved by George Miller's *Mad Max* saga. In a post-apocalyptic world people is forced

Bibliographic Notes

20. Official poster from George Miller's Mad Max: Fury Road (2015)

to kill for water resources. The whole movie is about a violent, endless race between evil and not-so-bad, in a steampunk-like world ruled by tyrants and starvation. This is the style of the movie and of all its features, including the steering wheel conceptual design. As part of a vehicle everything should be uniformed, follow the concept of the whole work, and the steering wheel doesen't make an eception. Its design is made to be rude, hand made, with a street-style and grotesque, so we can see there some wheel made of bones and skull as to proof that object carries the blood of the enemy. In this case the steering wheel it's not just a tool but is the symbol of the control over the people and the power to rule them. When a driver is beaten the winner collect its steering wheel in order to proof his value and strength. The tool became a symbol, it's interesting to notice that all its functions become secondary to its meaning. It's not important in this case, for the viewer, if the wheel is able to some particular functions of if it has some misterious features. In this movie the steering wheel is like the scalp for american indians, a trophy to be shown as a warning.

The steering wheel is more or less a modern archetype, its history is linked to the young car's industry, so it could be difficult to elaborate it in the way we want, to give it a personal looking and precise shape to reflect a message. For this thesis project i took inspiration from the approach in the movie-making process during my steering wheel's design, because if the shape it's not able to carry the message we want, the object itself it's not able to be seen as what we wanted it is.

In my particular project i took some inspirations from medical fields and i applyied them to my steering wheel in order to let the driver perceive it like an object that take care of him. The process is the same used during the phase of art-working at movie-making.

Bibliographic Notes

2.4 Modern times

As we saw in the previous paragraphs the steering wheel evolved into a complex object, and nowadays we can say it's no more just a steering wheel. This object followed the same evolution process that brought the cellphone to became a smartphone, so we could call this object a "Smartwheel".
Nowadays on the steering wheel we can find the air-bag, the controls for radio, music, temperature, the buttons for speakerphone, all the leverage for wipers, the windshield washers front and back, the two direction arrows, the sequential gearbox and maybe more. This is what we use today instead of a simple ring made of wood as it was during the 50s.
Because of all these feature is important to know what should be on a steering wheel and what rather is superfluos in order not to overload the attention of the driver.
One other aspect that's interesting to analyze is how design created a new approach to steering wheel aimed to help disableb people. Let's try to think about a person with just one hand, or with joint problems in his hands. Design thinking can attend to modify a steering wheel or, unilaterally, with the same approach is possible to design a new king of steering wheel easier to use also for persons with no problems in order to make this tool easier to use, more ergonomic or safer in general.
Last but not least it's important to briefly focus on materials innovation, soft touch material or others that help driver's sensibility and control, materials that make the steering wheel more rigid and lighter or just more pleasant to grab.

For this reasons the next few paragraphs will focus on remote controls, steering wheels for disable people and material innovations occurred in the last years of research and experience.

21. Citroen C4 Picasso's Steering Wheel (2013)

2.4.1 Remote controls and features

As i told the steering wheel features now a lot of tools embedded in it. What kind of controls do we have nowadays? Here you find a list[8][9] of them, just to figure out how this tool is becaming more similar to formula1's than standard's:

- Cruise control: including a buttons for setting and changing speed
- Phone answering: often with Bluetooth or similar wireless connections
- Up search: Upward radio station search function. Pressed once during cassette operation: Forward track search. Pressed twice during cassette operation: Fast forward to end of tape. If this key is pressed during fast forward, the cassette drive switches over to PLAY.
- Volume +: Increase volume for as long as key is pressed.
- Volume -: Decrease volume for as long as key is pressed.
- Down search: Downward radio station search function. Pressed once during cassette operation: Backward track search. Pressed twice during cassette operation: Rewind to start of tape. If this key is pressed during rewind, the cassette drive switches over to PLAY.

Bibliographic Notes

[8] From the article entitled "How Steering Wheel Controls Work" written on auto.howstuffworks.com by Kristen Hall-Geisler, 2012

[9] From the book user-free on Meeknet.com, "Multifunction Steering Wheel 2nd Generation." (June 3, 2009)

- **Radio/telephone changeover**: With this key, the search functions are switched between the radio and telephone. The radio display (frequency or station) or the telephone display (telephone number or name) appear in the instrument cluster.
- **Wiper lever**: control of the wiper's frequency
- **Direction arrows lever**: control of the two direction arrows, left and right
- **Light orientation controller**: a jack that allow the driver to control the height of the frontal lights
- **Temperature control**: a jack that can be moved up or down to increase or reduce the inner temperature of the car
- **Clacson button**: sometimes instead of the whole central part to push for clacson we have two button, one on each side (left and right)
- **Mode button**: usually we can find this button useful for many things, tipically to enter the menu and when pressed for few seconds to change some set-up

This list is not complete, it could't be because each company use to put whatever he wants on it and there's not a list with all the possible feature that we could find on a steering wheel. Is it useful to give a fascination of how many controls we are able to handle in comparison of past decades steering wheel and how is important to choose what's important and what is superfluous (but we will see better this topic in the next chapter).

2.4.2 Steering Wheels fo disables

As many tools we use nowadays also the steering wheel is customizable for handicapped persons, in particular for individuals that maybe can use just one hand. The one-hand driving is interesting to analyze when able-bodied people drive with just one hand, because of lazyness or just more comfortable driving, usually in city usage.

There are also several different types[10] of steering devices for disabled. Steering devices are apparatuses attached to the vehicle steering wheel to permit safe operation and aid in turning the steering wheel for drivers who must steer with one hand. It allows them to remain in contact with the steering wheel at all times. They come in a variety of configurations:

- Knob: A steering wheel device with a knob type grip.
- Tri-Pin: A steering wheel device with three upright pins to stabilize the hand and wrist of the driver.
- U or V Grip: A steering wheel device with two vertical pins to stabilize the hand of a driver.
- Cuff: A steering wheel device with a curved oval shape that fits around the hand of a driver.
- Amputee: A steering wheel device that integrates with a driver's prosthesis.
- Custom: A steering device designed for a specific application or driver.
- Palm: A steering device that wraps over the top of the hand.

Each of this kind of tools are designed to be attached to the steering wheel and each of them has a specific aim to help a specific user. This kind of approach could be useful when to design a steering wheel (as all kind of object) for a specific target or, at least, with more attention to a specific target. For example a Steering Wheel made for elderly people, or one made for sport driving as opposite, or even one made

Bibliographic Notes

[10] From the site www.rjmobilityservice.com

22. Spinner Knob (top-left image)

23. Quad Fork Spinner (top-right image)

24. Tr-Pin Spinner (bottom-right image)

25. Palm Spinner (bottom-right image)

26. Amputee Spinner (top-left image)

27. Single Post (top-right image)

for young drivers at their first experience on the street.

2.4.3 Material innovation

This last paragraph will focus on a secondary but not irrelevant aspect, the material selection. Dring the evolution of this object we traveled trough steering wheels made of only metal or wood to plastic shells and polymeric covers. Nowadays we essencially have two options: synthetic or natural. With synthetic we refer to polymeric materials like ABS, PC or PVC. In the automotive fields ABS is one of the most common plastic material because of its ductility and quality after casting. The other option is usually Leather or Suede, tipically chosen for purpose of elegance and luxury.
This material selection is made not just following the style of the car

Bibliographic Notes

but also with a compartimentalization of the parts. The ring is usually made with a rough material, with a great grip and breathability. Is normally used a material compatible with RIM (Reaction Injection Molding) like Polyisocyanate, that will be co-injected over the metal frame previously molded separately. The central part is made to protect the electric components inside the steering wheel. Usually the covers of the commands are made of a different color and a different finishing, tipically glossy instead of matte, to make them more visible. The hidden fram is made of Aluminium alloy, that could be bonded with Magnesium, Zinc or Manganese.

In some application, for example in racing, the frame could be replaced from a cave structure made of Carbon-Fiber, Kevlar or other composites materials. In this cases there's not separation between the central part and the ring, that will be just covereb by Suede.

Bibliographic Notes

28. Driving a Classic Ford in the Higway, POV (point of view) shot

3. The driver

Designing a steering wheel is of course important to look at the users, in this case al the users are drivers. This chapter will reflect on some aspects about the driver: which are driver's abitudes and attitudes? What problems could he occurs in? What are his needs? What happens to the driver during the trip? What are the statistic informations about driving and car accidents?
There are many questions to ask to predict and analyze how to approach the whole macro-target of this project.

3.1 Needs

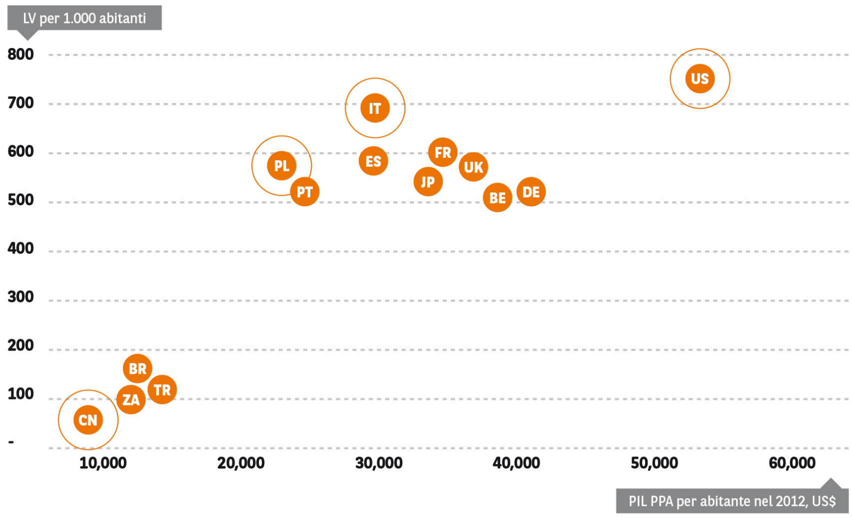
Before star talking about what is a driver, what kind of problem could he have, what are his features and conditions, it's important to briafly talk about the driver's needs.
First of all we should notice that the driving activities are something related to the movement, the will to go from a point to another one. This kind of activities have a social function related to the purpose of the trip: it could be a long journey to an holiday destination, a short ride to the job's place or town's supermarket. It's possible to notice two big groups in this trips: mandatory and optional ones.

A mandatory trip is a need that can't be delayed, driving in this case could be the only option instead of public transportation due to a fixed time or lack of transportation links. For optional trips there's no compulsion, the user can choose the timing and maybe use public transportation, move on foot or by bycicle. So we use the car especially for mandatory trips.

For these many reasons the market is slowly empowering, after the general 2008 crisis. Most of all it's important to analyse a little the level of distribution of cars, in the world and in the single countries. While the user's needs are the primary reason for buying a car, economical factors are the necessary requirements for this to happens. It's logical to assume that the higher is the purchasing power more will be widespread the distribution.

To support these statements i will report some statistics from L'Osservatorio Findomestic[11].

[11] Findomestic statistics from "L'Osservtorio" (2015), Page 03



29. L'Osservatorio Findomestic (2015), Page 03, Graphic

On the y-axis you can see the number of cars every thousand inhabitant, on x-axis the PIL average per-person in 2012.
It's possible to noticed that all the developing countries, most of th etime referred as BRICS (Brazil, Russia, India, China and SouthAfrica), are not yet in condition to guarantee most of the people to have a car, in a proportion of eight to one between the first (United States) and the last one (China).

According to some statistics by Findomestic[12] an average of 7% of consumes are by owner's car, approximately 10% is by using a general car (from driver's family or rented), 4% by public transportation. With consume it's assumed the whole amount of cash spent for transportation, buying a cara, fuel, ensurances, bus tickets ecc.
At last it's not useless to consider also the price of the fuel itself,

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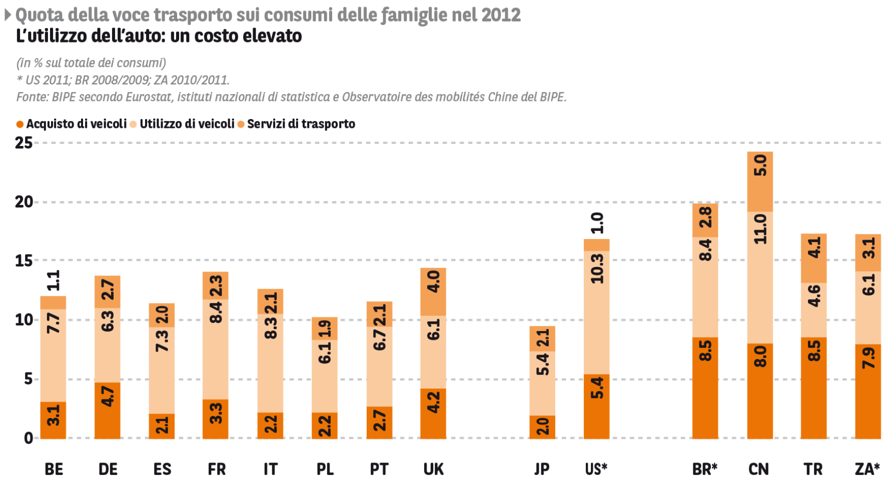
[12] Findomestic statistics from “L'Osservtorio” (2015), Page 25



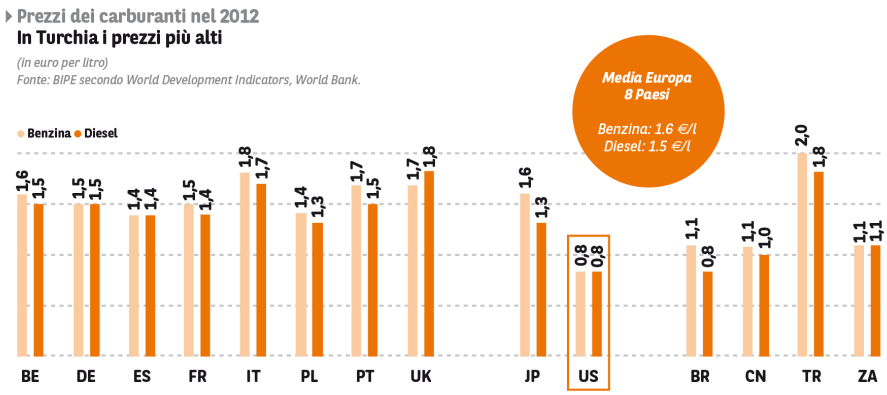
30. L'Osservatorio Findomestic (2015), Page 25, Graphic

because it changes a lot from countries also very similar to each other, and it changes also in some different parts of the country itself. Again, taking some statitics from Findomestic[13], we can see that Turkey has the highest price-per-liter and it's about 2€/L, when Europe's average is around 1.6€/L. This is a powerful factor in car's distrubution, at least in this country and considering all the factor i listed before. In other countries, like China, it's important to notice that the raw price is not so high, about 1.1€/L, but China's PIL-per-person is an average of one third compared to Europe one, then also the fuel price contribute in the less spread of cars.

In conclusion of these datas, the laws of the market set also the attitudes of people, allowing them to do or not something. With this discussion could be an error not to consider, as a social investigation,

[13] Findomestic statistics from "L'Osservtorio" (2015), Page 27

31. L'Osservatorio Findomestic (2015), Page 27, Graphic



some differences inside the macro-area of drivers. In general terms a driver could be male or female, young or elder, could live in a big city or in a little town, could simply have a different perception of the car related to its habits and its country.

Following the datas collected from L'Osservatorio Findomestic about the profile of car's buyers, we can produce a detailed profile of the customers. About the driving licence they stated[14] that in rich countries the huge mjority of population have a licence (84% in Germany) while in some developing countries it's a little minority (18% in China). These percentage show that there's a lack not just in the system of distribution and retribution, but also in the formation one. How could be possible to make the cars usage more widespread without a formation base that allow the customers to use it? It's not possible, in fact.

Bibliographic Notes

[14] Findomestic statistics from "L'Osservtorio" (2015), Page 31

Aging it's another factor that is necessary to consider. In Europe the majority of over 70s posses a licence, in the UK it's the 58%, when in the 1995-1997 period was just the 38%. It's a huge increasing inside this target and it will be considered for the project of this steering wheel. In Europe the average of the buyer is 52 years old, the younger country is of course China with an average of 35 years old customers and according to the research the car is perceived as a simble of independence and emancipation. This explain again how much is this country in development and how important is to focus differently between countries and ages. Perhaps is even more difficult to predict how the situation will evolve in the future, if the average in the developing countries will increase, if the age of Europe and US will be stable, will increase or even decrease. Is safe to assume that with the rise of life expectation in all this country the average will increase slowly but unavoidably. It's pivotal to consider this aspect if we eant to design product that will be smart for the new generations but mainly for the current evolved generations, the new elderly.

The other main target difference is between men and women. It could seem a sexist differentiation, but assuming that in Europe and US the equal rights is nowadays something entirely gained, it's not the same in a lot of countries out there, most of all the developing ones. In the UK for example[15] there is a huge polarization of the purchases by women, with a percentage of 35%. It could seem a disparity but we are talking about buyers, and it's worth noticing that such many women can today buy a car, a clear sign of an economic independence. In the US the percentage is even 50% between men and women, a phenomenon that could be explained also because of the multi-car per-family tendence. On the other side Turkey bring up the rear with a silly 11%, that could be explained with social reasons due to a society

[15] Findomestic statistics from "L'Osservtorio" (2015), Page 33

that doesen't actually consider the women as a resource at the same level as most of the other countries.

In conclusion there are some noticeable empiric datas about the perception of the cars, again thanks to the big work made by Findomestic with the document called L'Osservatorio. You can find now the results to some questions asked to a sample of buyers in 14 different countries. These are the results:

The car is..

a time saving
94%

a necessary form of transport
91%

freedom, independence, autonomy
90%

high waste of money
83%

a form of transport as many others
81%

It's evident that the perception, related to its use, is very positive, driving is perceived as something personal and flexible, something that adapts to owner's necessities, at a high cost. The cost is the most negative one, a car is not a occasional purchase, it needs mantainance,

Bibliographic Notes

energy provided by fuel, it brakes sometimes. A huge part of the sample see the car as a form of transport as many others, considering the public transportation, or private alternative forms (Motorcycle, Bike..), as something equal useful. This is true mostly for people that live in bigger cities, where the congested traffic promote the usage of alternative way of moving.

3.1.1 Safety

Driving and safety are linked to each other very deeply for the driver itself. But before starting analysing some aspect of this relationship, what is safety? How cane we say that something is safe to use and something is not? How can we differenciate safety factors and dangerous ones?

We could say that a safety factor could be sufficient when it can guarantee 100% of its faculties to prevent the driver from something dangerous. This is something ideal. The ABS system prevent the tires to stop and the car to slip through the street, but in very bad condition also that tested system could be useless. So we could assume that if it's not 100% useful, is 100% useless, but it's not, and this is the poin, percentages. We could say that the more is something safer, the less is the probability to have an accident.

The highest safety could be reached in many ways, something technical and linked to engineering, something due to smart design. The perception of the safety it's as important as the safety itself because it drives the buyer to the purchase. To make a good perception of the safety it's necessary to make the safety systems visible and easily accessible. In the new markets, China for example, safety is one of the

32. A dangerous way to use the phone while driving, without remote controls or hands-free bluetooth

most important factors during the selection of the products. As written in the research made by Findomestic[16] the 62% of the interviewed answer that Safety is the most important factor while buying a car. For safety we consider all those system that help the driver to have the control of the car but also all those systems that prevent him to get distracted, for example a remote control of the phone answering on the steering wheel or the radio controls again on the steering wheel.

Answer to the phone in particular contribute with a solid 22%[17] on the total of car crash causes. With those systems i spoke before the statistics decrease of more that one to four. It will never be zero percent because the driver, just for the fact that he is doing something that is not just driving, is still subjected to distractions. So it's important also not to overload the driver with useless informations, but we'll see this

Bibliographic Notes

[16] Findomestic statistics from "L'Osservtorio" (2015), Page 37

[17] According to the "Centre for Accident Research & Road Safety", Queensland, October 2012

point more in detail in chapter 4.3.1.

One last word about safety very related to this project. While safety is to prevent and protect the driver from outside factors, it could also be seen as to protect him from himself. A driver is human, subject to errors, to disease, he could fall asleep while driving, he could be angry and commit some bosh or worse, cause harm to himself or other people. I firmly believe that this could be the main point of future investments in automotive fields, and in particular on the design of the steering wheel. This tool is the only one, in the whole car, that is in direct contact with the driver during all the trip, with no break at all, not a second with no contact. It became natural to think about this tool to be the guardian angel of the driver, somthing that vigilate without ever stopping and, unlike the driver, without ever fail

3.1.2 Flexibility

What makes the car a perfect choice for users? According to some research by ACI (Automobile Club Italia)[18], one of the most important factors during the usage, and the purchase, of a product (a car in this case) is its flexibility. It's worth remembering that this is a thesis about a new kind of steering wheel, and like a company's product the customers can't chose the main design of it from a huge catalogue, but at most they can slightly customize it or chose between few models. So, when we speak about flexibility, i mean the general approach in this field and later a specific focus on what is it about steering wheel.

Going back to the topic, flexibility in product language is to design something that can easily adapt to anything he was built to, in slang we can call them "smart objects" but we'll see them in chapter 4.2.2.

[18] From the site www.aci.it in the sub-section "studi e ricerche"

33. The smart screen of a Mini Cooper (2015), it detects data together with the phone and warns the driver immediately

In generic terms a product to be flexible should be adaptable. Let's make an example, the watchband: it can be in metal, leather, fabric, and when you can't regulate it instantly you can add or remove modular components to reduce or enlarge it around your wrist. This is a great example of what means to be flexible.

A flexible steering wheel shound be customable, for instance. This already happens, you can choose the finishing, the number of spookes, if to have the remote command on it or not. But nowadays we couldn't call it a very smart object, because is a mainly passive tool. With passive i intend that the tool itself it's not performing something without the help of the driver, it's just a platform that you use for directioning and changing set-up, or maybe anwer the phone. The car indeed has a lot of active systems, let's think about the traction control or the ABS

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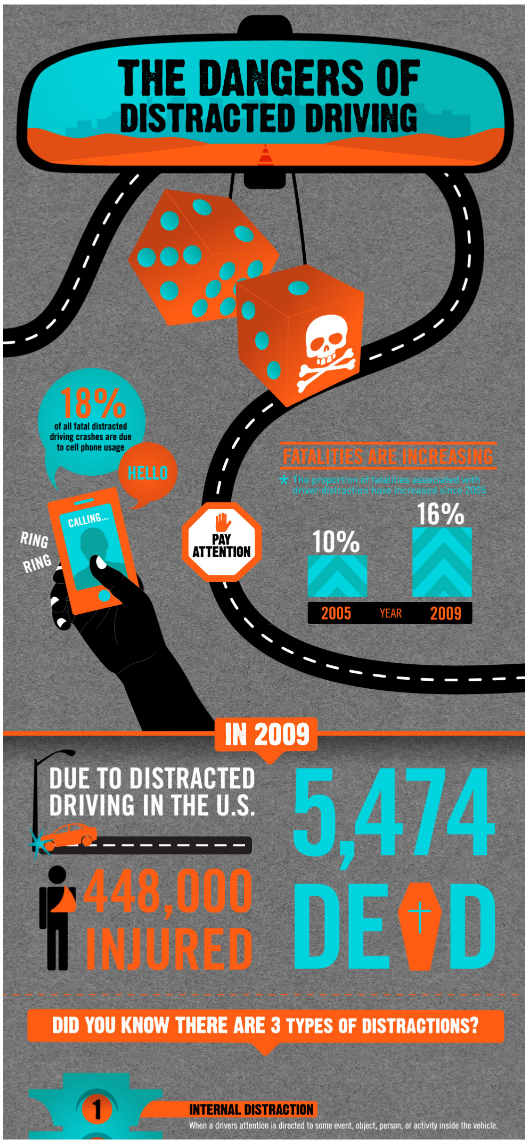


that with many other systems contribute to help actively the driver without it's intervention. With the prolification of smart objects it's a safe bet to aim on smart steering wheel, adaptive, with active functions and monitoring activities for the driver, to protect him from himself.

3.2 What happens when a person drives

Driving a car is a very complicate activity. While person drive car he does many activities at the same time with many parts of his body: he uses foots for change gears/accelerate/stop, his hands to direction the car, his fingers to change the radio/answer the phone/change the gears, his eyes to take care of the street, the hears to get warning sound signals from other cars, and the brain to coordinate everything. The driver is like a processor (an idea that will be developed in the chapter 4.3), a hellish powerful processord that try to understand thousands of stimuli, sometimes failing.

The failure, accidents in this case, are up to the driver's mistake most of the time. Human errors are the first cause of accident nowadays so should be important to focus future project on the driver itself, maybe monitoring him or helping him to fulfill his activities on the road. According to the assay by Douglas A Wiegman and Scott Shappell

[19] From the assay "A Human Error Analysis of Commercial Accidents Using the Human Factors Analysis and Classification System (HFACS)" by Douglas A. Wiegmann and Scott A. Shappell, February 2001, page 07

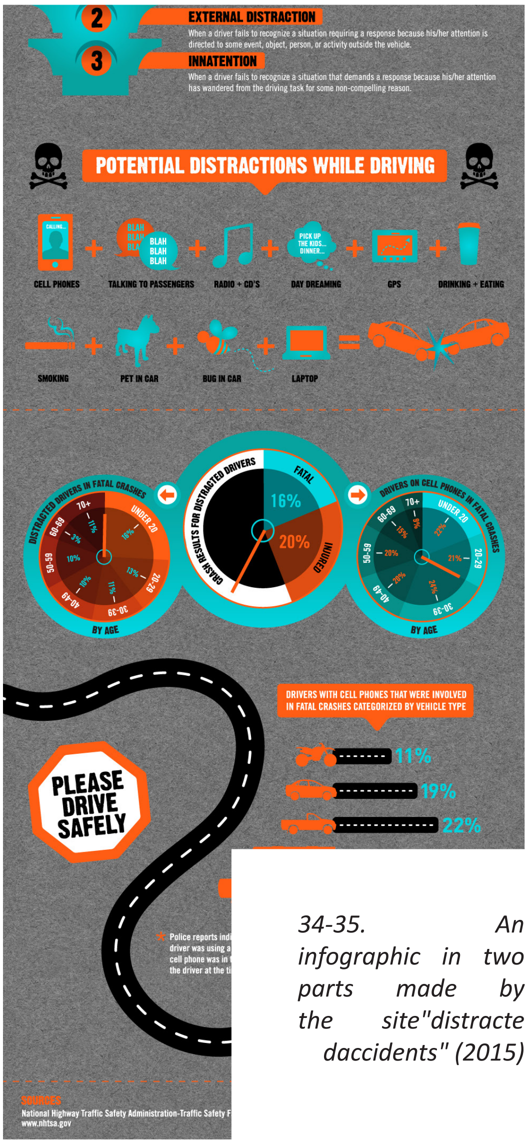
about civil and military accidents, about 70% to 80% of the accident are highly determined by human errors. These errors are caused most of the time by a lack of attention, the mood of the driver or unlucky situations.

According to some estimates[20] the number of over 70s drivers will increase by three times in the next twenty years. This research states that after the age of 65 the risk of car accident drastically increase. After the age of 75 the risk increase also more due to the high risk of car accident and related issues. Here some datas about it:

- 5% of all people injured in traffic crashes
- 13% of all traffic fatalities
- 13% of all vehicle occupant fatalities
- 18% of all pedestrian fatalities

In a 2013 NHTSA study[21], older people made up 9% of the population but accounted for 14% of all traffic fatalities and 17% of all pedestrian fatalities. NHTSA's *"Traffic Safety Facts 2013: Older Population"* (DOT HS 811 856) reports that:

- In 1997, more than 24 million people in the United States were over 70 years of age
- Representing 9% of the population in 2013, the 70-and-older age group grew 2.1 times faster from 2003 to 2013 than the total population



34-35. An infographic in two parts made by the site"distracte daccidents" (2015)

Bibliographic Notes

[20] from the article " Older Drivers, Elderly Driving, Seniors at the Wheel" publihed on www.smartmotorist.com

[21] from the statistics on "TRAFFIC SAFETY FACTS: Research Note" by NHTSA (National Highway Traffic Safety Amministration), November 2013

- In 2003 older drivers were 19% of licensed drivers; in 2013 they were 43% percent of licensed drivers
-Of traffic fatalities involving older drivers, 82% happened in the daytime, 71% occurred on weekdays, and 75% involved a second vehicle
- When a crash involved an older driver and a younger driver, the older driver was three times as likely as the younger driver to be the one struck. Moreover, 28% of crash-involved older drivers were turning left when they were struck, seven times more often than younger drivers were struck while making left turns
- Older drivers involved in fatal crashes and fatally injured older pedestrians claimed the lowest proportion of intoxication, defined as a blood alcohol concentration of 0.10 grams per deciliter or higher
- While only 55% of adult vehicle occupants (ages 18 to 69) involved in fatal crashes were using restraints at the time of the crash, 70% of fatal crash involved older occupants were using restraints
- On the basis of estimated annual travel, the fatality rate for drivers 85 and over is nine times as high as the rate for drivers 25 through 69 years old

We can safely assume that elderly people are the target of the future of automotive. These datas are likely to increase year after year and to became the most important group to focus on the next decades.

But what did we do to solve this problems? Mandatory driving tests, which requires retesting for anyone involved in a fatal crash or three or more crashes in one year, requires drivers over 70 to retest if they are involved in two or more crashes in one year.
What else could be done? Deficit screenings for example. Screening could be given to all drivers for whom age-related decline is suspected

and whose performance is viewed as a safety concern for themselves and other motorists. In addition, health professionals and others who work with older populations could administer the tests. Screening could become a part of the regular process of license renewal. By reducing testing time, drivers could be quickly screened and identified either as capable, or as in need of further testing. But the most likely thing to do is to design for elderly. Project most of the products with attention to the safety of the weakest, try to make them feeling safer and to prevent their errors, to save their lives and other's.

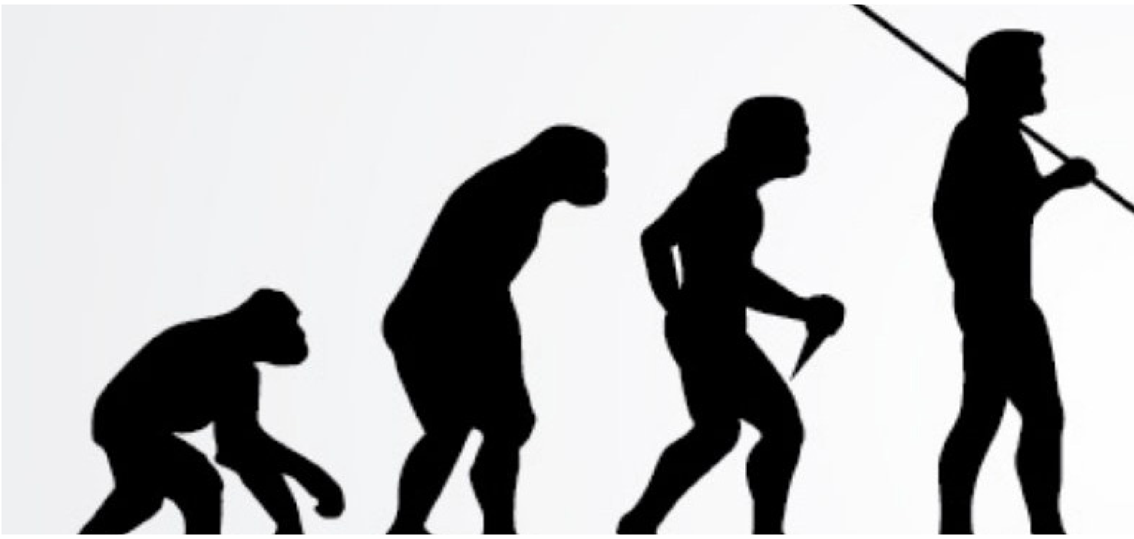
3.3 Human factors

In conclusion of this chapter there are some personal thinking about humans. We are fallible.

"Once we know our weaknesses they cease to do us any harm"
[Georg Christoph Lichtenberg]

36. A colored image of Georg Chistoph Lichtenberg

I think this quote explain very well how to approach the problem of safety, the prevention of the driver in general. Lichtenberg was a physicist and a writer, well known in the world for his aphorisms. He stated that the first thing to do to solve a problem is to understand it. This is good also for design thinking and product design in general, choose a problem, analyze it, deassemble it in smaller groups, find a solution and then apply it to the project. It's quite safe to say that the main problem found in this research is about human errors and factors. Ippocrate is focused on this aspects, in particular on the ones about the physical state of the driver with all the possible consequencies of a bad healthy state on the wheel. Humans are not easily predictable, we are complex creature used to manipulate the environment (and you will



se a focus-on chapter on it in the nex one), to manipulate energy and technology for many reasons, bu we will never be able to turn ourselves into machines, at least not in the nex decades. To solve this problem we have to use many tools, designed to be efficient, specialized and not to much intrusive, because we can't process to many actions at the same time.

Moreover a human person is made of "standard" components, those factors i mentioned before. These components are all those parts that made us a perfect biologic machine, but we can't modify them, we have to design all the tools we want to develop with dimensions compatible to human measurements, with right materials, finishing, with a well thought shape that's enough assimilable and feature comprehensible for our society culture.

36. A satirical image about how humans are "evolving" into something more and more technological addicted

Not less important is a particular attention to what's necessary and what's superfluous, in terms of pure technology but also in interaction and usability. For example, for a certain function should be better an analogic command, a digital one or a voice one? It depends from the function itself, in all these cases the better option is to contextualize, to put ourselves in that situation, try it and figure out how the user feels in that.

As designers and developers solve problems is our duty, solve them efficiently is our purpose.

Bibliographic Notes

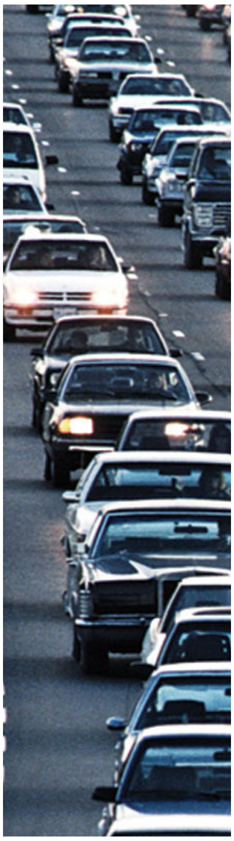
38. An impressive image about a city filled in traffic during all night long

4. The context

Speaking about the users is not less important to speak about their behviours, the environment where they are used to act for a specific activity, driving in this case.
Driving is a complex task that relies heavily on visual information. Looking away from the road at the wrong time can therefore have severe consequences. Driver distraction has been acknowledged as one of the leading causes of crashes as we've seen in the previous chapter.
Drivers constantly direct their gaze to different areas to obtain detailed information from the traffic environment. When and where drivers look is driven by expectations and experience with similar situations, as

well as stimulus properties of an object such as movement, luminance, size, color and contrast.

The results from this study highlight the need to take driving context into account when evaluating the influence of different secondary tasks, in-vehicle user interfaces and glance metrics on driving safety, including the risk of crash involvement.



39. A long car queue in a german main highway

4.1 The environment

When we talk about a complex object like a steering wheel, in a far more complex object like a car, all the aspects of the driving experience are worth to be examined, not less the environment. An environment is the context where something is added in. What's the environment of a driver's experience while using a steering wheel?
First of all, the inside of the car. As a very complex object as i said before, a car create an environment that is measured on the human being to be comfortable, readable, easy to use, technological and safe. But not everytime all these features come to an easy approach. Most of the time the user don't even know all the functions of the buttons and the LEDs, this creates an overload of information and maybe a lack of attention during the drive. This chapter will focus on this aspect in particular in the next few paragraphs.

The environment itself is the main protagonist, together with the driver, in the activity of driving. We have to think in particular to some example that resume quite well the importance of consdering the environment: city traffic and main highway.

Cities are centres of people aggregation, the summ of technology concentration, but this bring us to have a higher density of population and in many cases this ends with many difficulties to menage all these informations. For a driver that needs to travel for few kilometers in the traffic of a city there are a lot of informations to process: hundreds of cars around him traveling in the same direction, traffic lights to observe carefully, crossroads, secondary roads not regulated by airfield lighting, motorcycles, bikes, pedestrian crossing, eventually police cars of ambulances. We could immediatly say it's a pretty dense environment to drive in, and it seems incredible that a single human can read all these informations in few seconds and acting accordingly to them. The time is in fact one of the main point on this aspect. If we think about reaction, each little distraction can increase a lot the time of breaking for example, and this is a very important factor to consider. According to a simulator online[22] the time we are, on average, distracted are related to the tool we are using or the activity we are doing, these are the results:

- Answering a Phone Call	10.6 seconds
- Replying to Text Message	33.6 seconds
- Grooming	14.4 seconds
- Reading Directions	7.0 seconds
- Drinking Coffee	6.3 seconds
- Adjusting Radio	1.3 seconds
- Adjusting Climate Control	2.7 seconds
- Adjusting GPS	26.7 seconds

It's noticeable that most of the tools we suppose help us not to be distracted are, in the middle of a context that is difficult by itself, distractive. Let's think about the GPS we use commonly the first time we go somewhere, or answering the phone with a hand-less command, or changing the radio channel, how could be empowered these features

Bibliographic Notes

[22] simulation made on www.distracteddriving.caa.ca with different ype of road and different street conditions

and how could we be monitored in a better way? We could resemble all these activities and monitor the attention by itself. We will see in the chapter 6. some example of eyes tracking useful to monitor the attention level.

The other important environment is the main highway. They are characterized by high speed, faster reaction requirements to the driver and many advertisement. Driving on a highway could also be very stressful because the person must stay in a certain position with his harms for a long period. There could be many ways to procede to solve all these problems, acting on the shape of the ring of the steering wheel reducing the stress on the wrists. There are already on the actual cars some systems that work for the driver in order to decrease his efforts during the trip on the highways, a great example is the cruise control.

40. A cruise control's command on Audi A4's steering wheel (2009)

This smart system let us select a "cruising speed" tht remains fixed until we deactivate it or until we use the breakes under a certain limit level, tipically 40km/h.

All these features will be analyzed deeper in the next paragraphs.

4.2 Vehicles

Vehicles are of course the main protagonist while speaking about driving. But the vehicle itself is a collage of many different tools. For this thesis is important to focus on those features and tools that intervene on helping the driver during the trip. In particular on a car we can find many feature all together on the steering wheel or around it, of course because it's the center of the attention for the driver.

Introducing this argument, let's see what it's a vehicle. With this term we mean something technological advanced that is design to carry people, but not just that. There are vehicles made to carry from five to seven people, others like buses designed to carry dozens of people, there are also trucks made to move food around the world, some of those have a fridge trailer, some of them carry animals. All these typologies have different needs and the designer have different purpose on working with one of those. In this scenery cars are the ones with the most general purpose, the less specifics, but the most widespread needs of all. A car is made to carry people of all ages, to carry passengers of all ages, move food and all kind of products, and is made to be as comfortable as possible. All kind of vehicle consider the ergonomics percentages factors[23] on top of the importance. All these kind of vehicles are driven by people and most of them carry people, but how could we choose the ergonomics? First of all, we should

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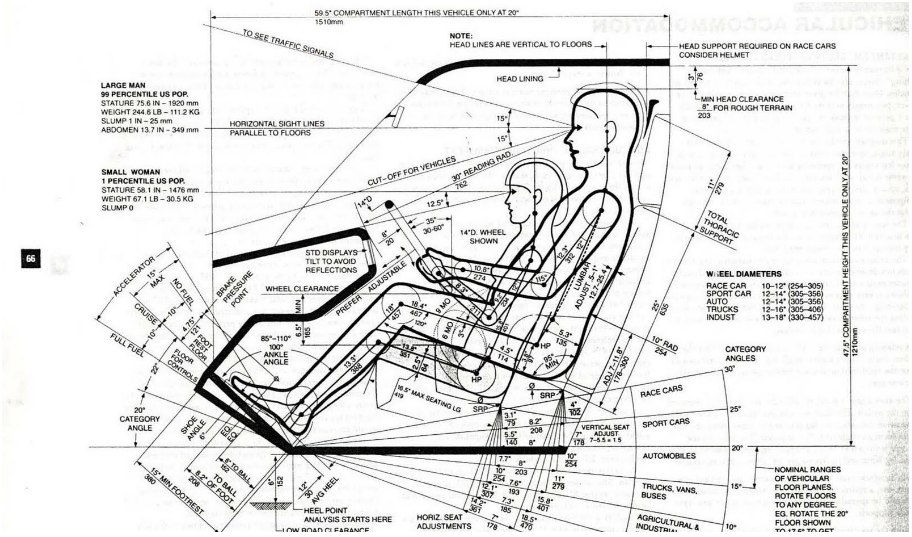
[23] "Human Factors of Visual and Cognitive Performance in Driving", edited by Càndida Castro, 2009

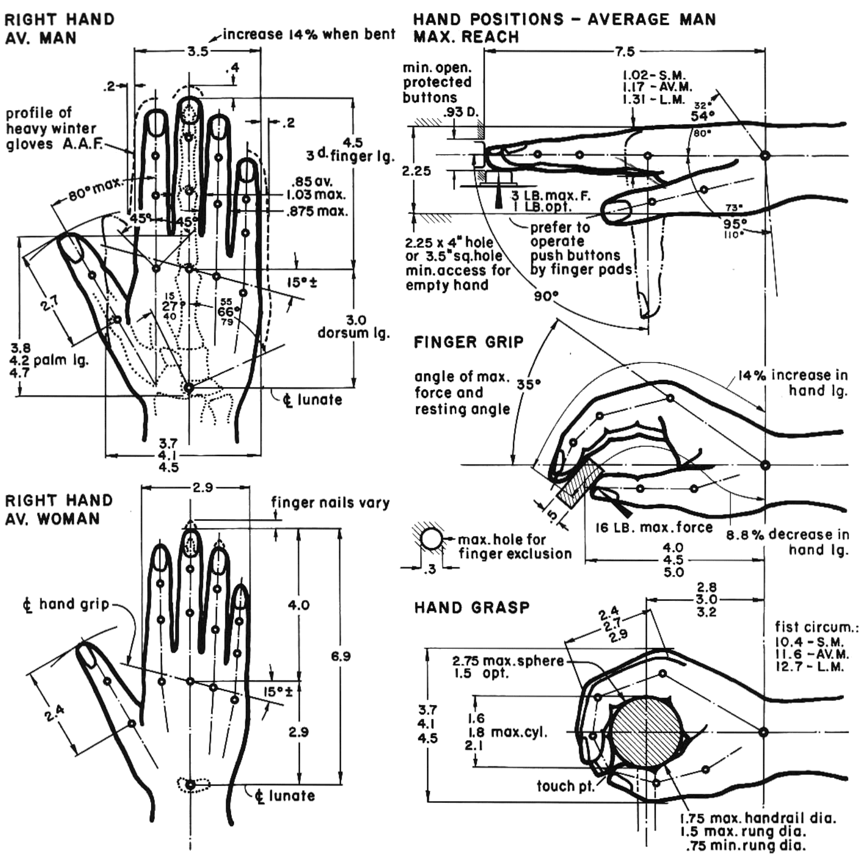
41. General car ergonomics studies, from 2.5% to 97.5%



select a specific target. Usually for cars is considered all the wide-range between the 2.5% percentile female to 97.5% percentile male, in order to have the bigger range possible to cover a huge target and sell cars to the most people possible. The same is done for the dimensions and the ergonomics of steering wheels, but taking the measurements of the hands as you can see in the figure on the right.

We could divide this discussion in two main points: smart vehicles and smart objects. The main difference is that a smarth vehicle is a car, or a vehicle in general, that with his particular features can directly help the driver. The smart objects is that huge world of interactive mobile tools that can be mounted in a car or wherever and they help the user in general during many activities. We will consider now the smart objects related to the activity of driving.

HAND MEASUREMENTS OF MEN, WOMEN AND CHILDREN



HAND DATA	MEN			WOMEN			CHILDREN			
	2.5% tile	50.% tile	97.5% tile	2.5% tile	50.% tile	97.5% tile	6 yr.	8 yr.	11 yr.	14 yr.
hand length	6.8	7.5	8.2	6.2	6.9	7.5	5.1	5.6	6.3	7.0
hand breadth	3.2	3.5	3.8	2.6	2.9	3.1	2.3	2.5	2.8	—
3d. finger lg.	4.0	4.5	5.0	3.6	4.0	4.4	2.9	3.2	3.5	4.0
dorsum lg.	2.8	3.0	3.2	2.6	2.9	3.1	2.2	2.4	2.8	3.0
thumb length	2.4	2.7	3.0	2.2	2.4	2.6	1.8	2.0	2.2	2.4

42. Hands ergonomics studies , from 2.5% to 97.5%

Bibliographic Notes

4.2.1 Smart vehicles

As stated in the previous paragraph will be considered s vehicle just the segment of cars, so it's better to talk about "Smart Cars". What is meant to be a smart car? We could safely assume that all the cars that you can find in a concessionary is smart enough. Lets think about the heating system of the car. Nowadays we can have a system, almost for every car, that separate the heating distribution in two areas, left and right: this is called "dual-zone heating", a smart system that provide to help the most of the people in the car having the perfect environment. But most of the cars have many of this kind of system: automatic wiper that activate by themselves when is raining; automatic door locking; park assistant that show you with a sound output the distance from other cars; many others.

What about the steering wheel? Actually, there are many of them mounted on the steering wheel. Mercedes[24] developed a system that is able to mantain you everytime on the right direction.

42. Active Lane Keeping Assist by Mercedes

The lane-keeping assistant warns you by shaking the steering wheel and, eventually, automatically breaking the wheels. The car has some radar sensors that able to detect the level of the traffic around you while a rear cam controls if you are crossing the middle-line of the street. If the program states that there are possibilities for an accident it automatically come in action and bring you back on the optimal way of driving. This smart system is a mix of sensors and cameras and through your steering wheel is able to drive you safely out of the danger-zone.

One other interesting system, again by Mercedes[25], is the Automatic

[24] From the description on the official mercedes site "http://m.mercedes-benz.it/it_IT/active_lane_keeping_assist/detail.html"

[25] From the description on the official mercedes site "http://m.mercedes-benz.it/it_IT/traffic_sign_assist/detail.html"

recognition of road signs. A frontal mounted camera register all the limit waring on the way and those are compare to your actual speed. Those informations are shown on the screen of the car and, if you exceed out of the limits, the car itself warns you with acoustic, visual and tictile output on the steering wheel.

43. Automatic recognition of road signs by Mercedes

What's important to notice is that most of these systems are related to the driver's safety. The remainings are about the driver's comfort, nothing else is taken into account. About safety nowadays many development are being made about the user's physical monitoring. There are few companies that are taking into account this field, on the top we can find Toyota. This company actually developed a steering wheel able to detect, with a light-spectrum sensor, the driver's heart-beating frequence and show him the results on the car's screen. This is probably the first step towards the full monitoring of the driver, and this thesis is going in that direction. Design a particular steering wheel that is able to take care of you during your trip, that is smart enough to evaluate your condition, show you the results and in the same time act accordingly. This could be consider a smart object mounted on a standard car, turning it into a smart vehicle. The importance of exploiting the steering wheel is related to its usage, a tactil output is very important while driving, and its worth noticing that the steering wheel is always in front of the driver, no mater what kind of vehicle we try to analyze. This could seems evident and foregone, but it's actually not. Having the controller of the car right in fron of the driver force him ti interact with it all the time, and it's experience of everybody being obstructed while trying to see the car's screen by the steering wheel position. A smart steering wheel could be self-sufficient, having everything you need in the palm of your hands.

Bibliographic Notes

4.2.2 Smart Objects

Our lives are getting every day more comfortable thanks to many devices and habitudes. We are actually getting addicted for technology. Let's think about staying one week without our laptops, this could be very problematic. We entrust, literally, our life to our devices, smartphones, computers, and to the whole net. For example our credit card datas. Nowadays these tools can speak to each other, like of they were smart enough to think and act with no order from humans. This kind of products are used not just in sci-fi representation, today is something we can see, we can touch, use and of course design. Home-automation field of product is going through the future very quickly, designin smart-fridge able to give you what you need in the right time, at the right moment, with the weight you need of it. It could seems an exercize in style, useless at the end, but it's not. Since the end of the nineteenth century the human kind move towards automation in every field of project. Now we can use robots to make our product, we can actually use robots to make themselves, and other robots provide them their energy, with a neverending cicle.

All of these example are considered smart, of course. But for this thesis it's important do look at those kind of product related with the field of automotive, and in particular with the activity of driving and the steering wheel.

Since i stated that safety is one of the most important point to take into account in this field of design, the care of the driver itself is one of the main point of this project. Smart objects are able to interact with other products but also with the user, and they analyze the world through different kind of sensors, that can be biometric, light spectrum analyzer, thermal sensible or of other type.

Last but not least a smart object interact not just with other smart objects or users, but also with virtual interfaces. We could call these "smart virtual objects", the brain of this system. As sommarized by Stefan Poslad[26] we could say:

- Humans use models of smart objects situated in the physical world to enhance human to physical world interaction

- Smart physical objects situated in the physical world can model human interaction in order to lessen the need for human to physical world interaction

- Virtual smart objects by modelling both physical world objects and modelling humans as objects and their subsequent interactions can form a predominantly smart virtual object environment

Folowing these sentences we can say that smart objects are shaped to be user-friendly, ergonomic and easy to use. They are designen to be a surrogate of the humans in some activities that they can't afford or that are useful to help them in. In virtual world this is translated in models, used by smart objects to empower their efficacy and anticipate some kind of events in the real world. So the concept "smart" for a smart physical object simply means that it is active, digital, networked, can operate to some extent autonomously, is reconfigurable and has local control of the resources it needs such as energy and data storage. A smart object does not necessarily need to be intelligent as in exhibiting a strong essence of artificial intelligence, although it can be designed

Bibliographic Notes

[26] From the book "Ubiquitous Computing Smart Devices, Smart Environments and Smart Interaction" written by Stefan Poslad, (2009)

to also be intelligent. Physical World Smart Objects can be described in terms of 3 properties[27]:

- Awareness: is a smart object's ability to understand (sense, interpret, and react to) events and human activities occurring in the physical world
- Representation: refers to a smart object's application and programming model
- Interaction: denotes the object's ability to converse with the user in terms of input, output, control, and feedback

Based upon these properties, these have been classified into 3 types[27]:

- Activity Aware Smart Objects: objects that can record information about work activities and its own use
- Policy Aware Smart Objects: are objects that are activity-aware objects can interpret events and activities with respect to predefined organizational policies
- Process Aware Smart Objects: processes play a fundamental role in industrial work management and operation. A process is a collection of related activities or tasks that are ordered according to their position in time and space

All these kind of activities can be translated into a device, such as a steering wheel, and act independently of the driver's will to assist him. This system could be refers to the "Internet of Things" (IoT), a brain-like structure inhabited just by smart objects related to each other with a network net. The Internet of things is evolving into an Artificial Intelligence construction, where the limit of evolution is up to the ability of human kind to translate their needs.

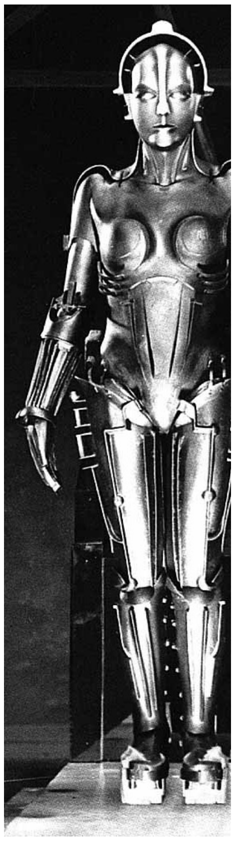
[27] From the book "Smart Objects as Building Blocks for the Internet of Things" by Fahim Kawsar, Daniel Fitton and Vasughi Sundramoor, (2010)

4.3 The man and the computer

The whole discussion about "Smart products" world was meant to be a preparation for a different topic, the human behaviours and Human-Computer interactions.

Driving activity is an active process while the user experience the collection of many datas responding to a certain amount of stimuli, translating them into operative actions. But humans are not computers, the reaction speed of a human is related to many things we talk about earlier in this chapte. Our processing capacity is limited, while computer's one is huge and perfectly menageable, capable of not loosing even one single data during their collection. But computers are not able to improvise, they just follow a plot previously designed by humans during the prediction of their actions as computers. All this topic has been a long discussion through our recent culture, since we invented machines we thought about their abilities and their lack of operating elasticity, but also to human's failure.

We could utopistically call this "Compartimentalization of Roles". Some activities are upt to the users and some other are to the machine. This collaboration is meant to be something that empowers people's experience, something that maybe in the future will bring human king to a world made of hybrid people, half biologic and half synthetic. We are already experiencing something very radical in that way: the bypass interventions to fix heart's disease are something that modify the human body and make it partially a machine. The same can be done for lost limbs, bones or whole organs. These are invasive intervention and most of the time are something that is not meant to



44. Mariarobot, the famous character from Fritz Lang's "Metropolis" (1927)

Bibliographic Notes

be temporanemous. On the other side driving is an activity that is not all-day-long, so it's necessary to think of something that can activate and deactivate, maybe automatically. Something not invasive.

To make men and machine dialogate we need to work on the interface. The interface could be visual, most of the time it's a screen. This could be empowered by sound messages or tactile sensations. These aspects will be analyzed in the next two paragraphs with particular attention to how the user experience the elaboration of data and how could correctly be done the interface of a smart object.

In the next two paragraphs will be analyzed the point of view of the driver, about feature limitation and elaboration process of the stimuli. This topic will bring our discussion on a deeper level, to comprehend better how human's rections work.

4.3.1 Limit the features

"What goes on when a man drives an automobile?"[28]

[James S. Gibson, 1938]

This was he question that James S. Gibson was asking about eighty years ago, when automobile field was coming up in some wide-spread ways around the world thanks to Ford's work with the Model T.

Today this question could be much more actual, but could also be more difficult to answer it. Eighty years ago the situation was very different: less autovehicles on the streets, less speed, less connectivity through cities and less powerful infrastructures, less tools on the cars themselves. It was easier to manage a trip to reach a destination, but

[28] From the book “Human Factors of Visual and Cognitive Performance in Driving”, edited by Càndida Castro, 2009, Preface IX

from an other point of view it was less comfortable. With all these stimuli nowadays is difficult to say what keep on your tools, what do you need to hide and maybe to remove definitely. For example we turn the analogic system of the radio in a more compact, digital system integrated on a single touch screen. This could be interpreted as a simplification, but actually it's not. On the same screen we added the navigator system, the rear camera for parking assistance, various mapping devices of traffic and streets signals. This means we tryied to simplify a system condensing some features in a single one, but we also added something we, as drivers, need to process during it's usage.

If we think about electric car, or hybrid ones, we could add all those feature that help us to menage the status of the assistant engine: battery charge, percentage of contribution of the electric engine, range of usability.

All of these additions are for sure meant to be helpful, but in the end maybe they are harmful or, if not, at least distractful, and in the end useless.

According to some resources[29] driving is an active process while the driver do something answering to stimuli. The amount of stimuli he can process depends on the driver and on the kind and quality of stimuli he's receiving. With this type of design-thinking, limiting the amount of features and tools the driver is using is quite important, as important is the quality of the output from the device so as he could be able to process them quickly. Condensing information is one other main point for this king of process: instead of having many functions dissipated on a huge area, should be better choose wich one you really need and put them together on a single platform. This is possible to do

Bibliographic Notes

[29] From the book "Human Factors of Visual and Cognitive Performance in Driving", edited by Càndida Castro, 2009, Page 26

when these feature have something in common, for example they are all about electric engine, or heating-system, or maybe the healthy-care system.

According to some insights[30] it's very important to maximize the efficiency of informations transmission channel by making the redundancy low. This means that during the design phase it should be positive to think about what is being repeated unnecessarily in order to avoid data dispersion and decrease the amount of data the driver is able to collect in every moment. For this purpose something could be made during the concept. In the research made for this thesis[31] there is written this simple task:

"Divide a continuous signal in discrete, simplier levels"

This is about information singnals in general. Everything could be divided into simplier activities or output, until a certain level. The risk on this side is to divide to much and put too many sub-categories. Here, such as before in this topic, is up to the designer to find the better balance between what is important and what's superfluous, what is truly needed and what is accessory.

4.3.2 Stimuli and elaboration process

Human's experience is daily characterized by detection, collection, elaboration and processing of datas from many kind of activities. This could be done essencialy in two ways[32]: active process or passive process. When we do somethin actively with a tool, we use that object to personally make something, for example we use the phone to call

[30] From the book "Human Factors of Visual and Cognitive Performance in Driving", edited by Càndida Castro, 2009, Page 49

[31] From the book "Human Factors of Visual and Cognitive Performance in Driving", edited by Càndida Castro, 2009, Page 64

[32] From the book "Human Factors of Visual and Cognitive Performance in Driving", edited by Càndida Castro, 2009, Page 27

someone. A passive activity is when we use an object that makes something for us automatically without our help, for example the ABS SRS system that prevent the car from accidental slipping.

According to research[33] during the active process we could schematize in this way:

STIMULI -> PROCESS -> INTERPRETATION -> DECISION -> ACTION

Before it says [34]:

"A recent model that can be applied to driving is Endsley's (1995). Thisauthor highlights the need to take into account the great variability of informationbeing processed as a basic feature of driving. Environmental and task conditionschange constantly while driving, resulting in drivers having to carry out continuousdecision making based on those variable stimuli conditions. Situations have to becontinuously assessed and immediate changes must be anticipated in order to makethe right decisions. Endsley refers to this as situation awareness, deAning it as the perception of environmental elements in terms of time and spatial measurements,understanding their meaning and foreseeing their state in the immediate future"

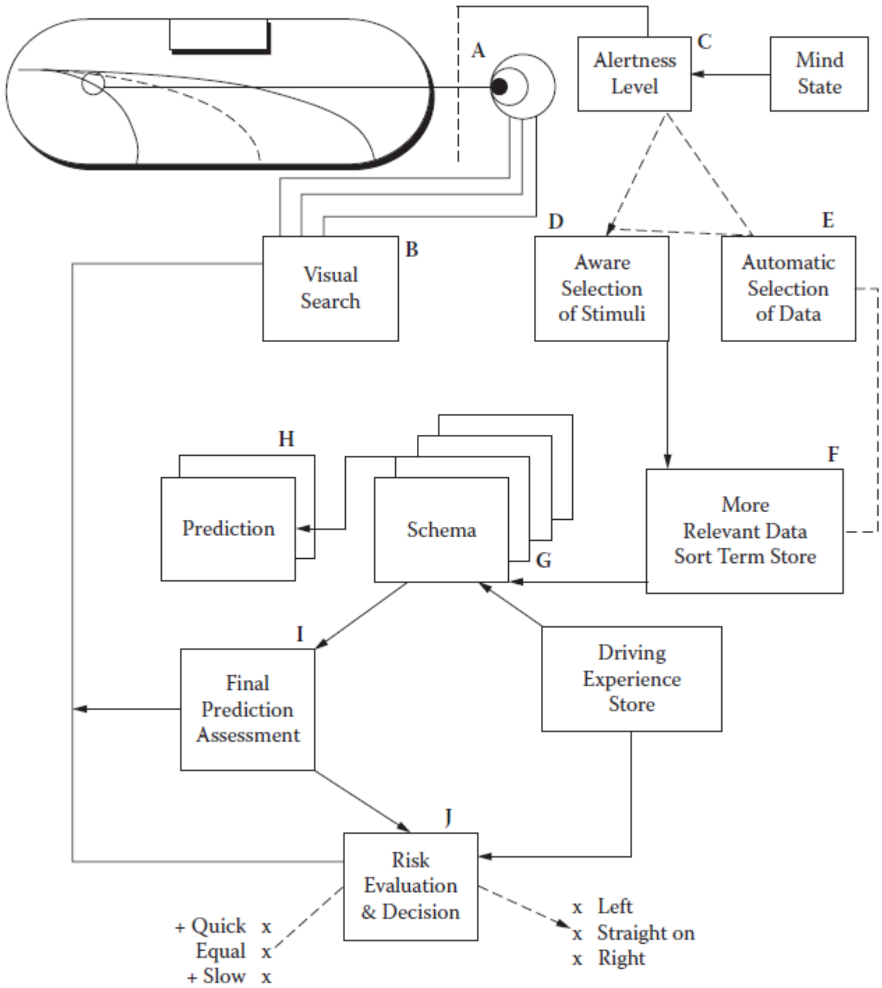
With these informations is possible to predict the behaviour of the driver and drive him to the right decision. His actions ar describable in three levels: perceiving the stimuli about traffic, speed, other vehicles, understand the situation by mixing his previous experience and knowledge to comprehend it, then foresee how the situation could continue in the immediate future and act accordingly to this in order

Bibliographic Notes

[33] From the book "Human Factors of Visual and Cognitive Performance in Driving", edited by Càndida Castro, 2009, Page 34

[34] From the book "Human Factors of Visual and Cognitive Performance in Driving", edited by Càndida Castro, 2009, Page 33

45. Diagram of driver's perception and decision-making process (Moore, 1969)



to let everything go in the better way possible. Usually we do this in few instants, but it depends on the particular situation. According to the research[34] monitoring driver's attention and his perception could hugely increas the amount of avoided accidents in driving. Around 90% of them[35] are due to the driver's disattentions and human errors in general.

The keywords for this topic are definitely decrease the required speed of reaction for a certain activity and in the same time increase the efficiency of the answer to it. In the end reduce the uncertainity of a certain event.

4.3.3 Risk and danger

Risk and Danger have a very different definition but in the end they are somethimes used for the same one. Actually a risk is th probability that a certain event have to manifest in some conditions, the more is risky the more is probable. For example a plane disaster is, according to statistics, much less probable to happen compared to car accidents. On the other side Danger is the amount of damage that an event provide to the user when happens.

Risk and Danger are related by a non-directional proportion, according to this statement:

"The less is risky, the less is probable, the more is dangerous"

Common events are more risky, because the refers to a much bigger statistic sample or just because they refers to some actions that are not

Bibliographic Notes

[34] From the book "Human Factors of Visual and Cognitive Performance in Driving", edited by Càndida Castro, 2009, Page76

[35] From the book "Vision, visibility, and perception in driving" edited by Hills, B. L., 1980, Page 183

common to end in a damaging conclusion. Uncommon events are less risky because the occur, accordin to statistics, less times in a damaging conclusion. Taking again the example of plane disaster, we can safely say that traveling by plane is much less risky than by car, is much less probable for a plane disaster to happen than a car crash. But when occurs a plane disaster is much more dangerous. The worthyness of the analysis of what should we consider more is up to the context.

In automotive fields there are some causes that are not much risky but very dangerous when they occur. For example a crash by biologic disease is accounted for around the 5% of the total (as we stated in the chapter 3) but have an account of 80% of death while driving. Working on this topic could mean that, with a precise focus on the problem, we could eliminate that 5% from the equation, more or less. Working on uncommon problem is useful for many reasons: aliminate problems that most of the time are not considered instead of more common problems but simultaneously make in evidence exactly those common problems and give them more importance because of the elimination of uncommon ones.

Moreover for uncommon events we can count on a very low level of prediction. Let's think about earthquake: they are not much risky because they occur not very often an just in sismic area, so it's no high probable for an earthquake to manifest, but they are very dangerous and we as humans are not able yet to predict when, where and with how much power an earhtquake will manifest. The same approach is useful to describe some events in car driving. If it's possible to predict and avoid common events on a certain scale, and in the same time predict and avoid some uncommon one, the driving experience can be slightly improved and the driver can feel safer.

Working on the uncommon it's not easy, it like to explore an unseen area and figure out what are it's characteristics, what problems are there, how to solve them in a practical way. It's an activity fed by curiosity and the will to face those problems that just few care about.

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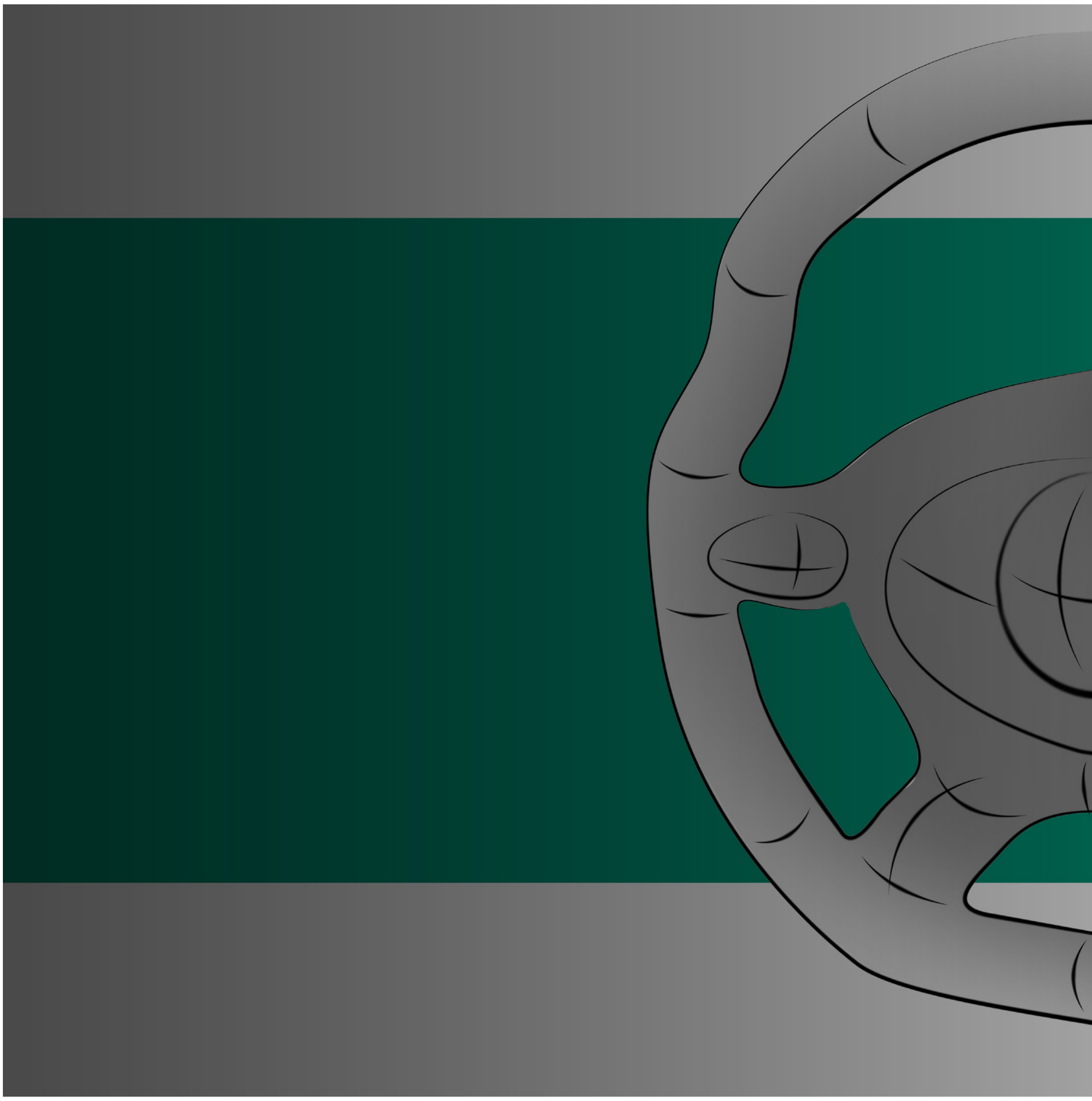
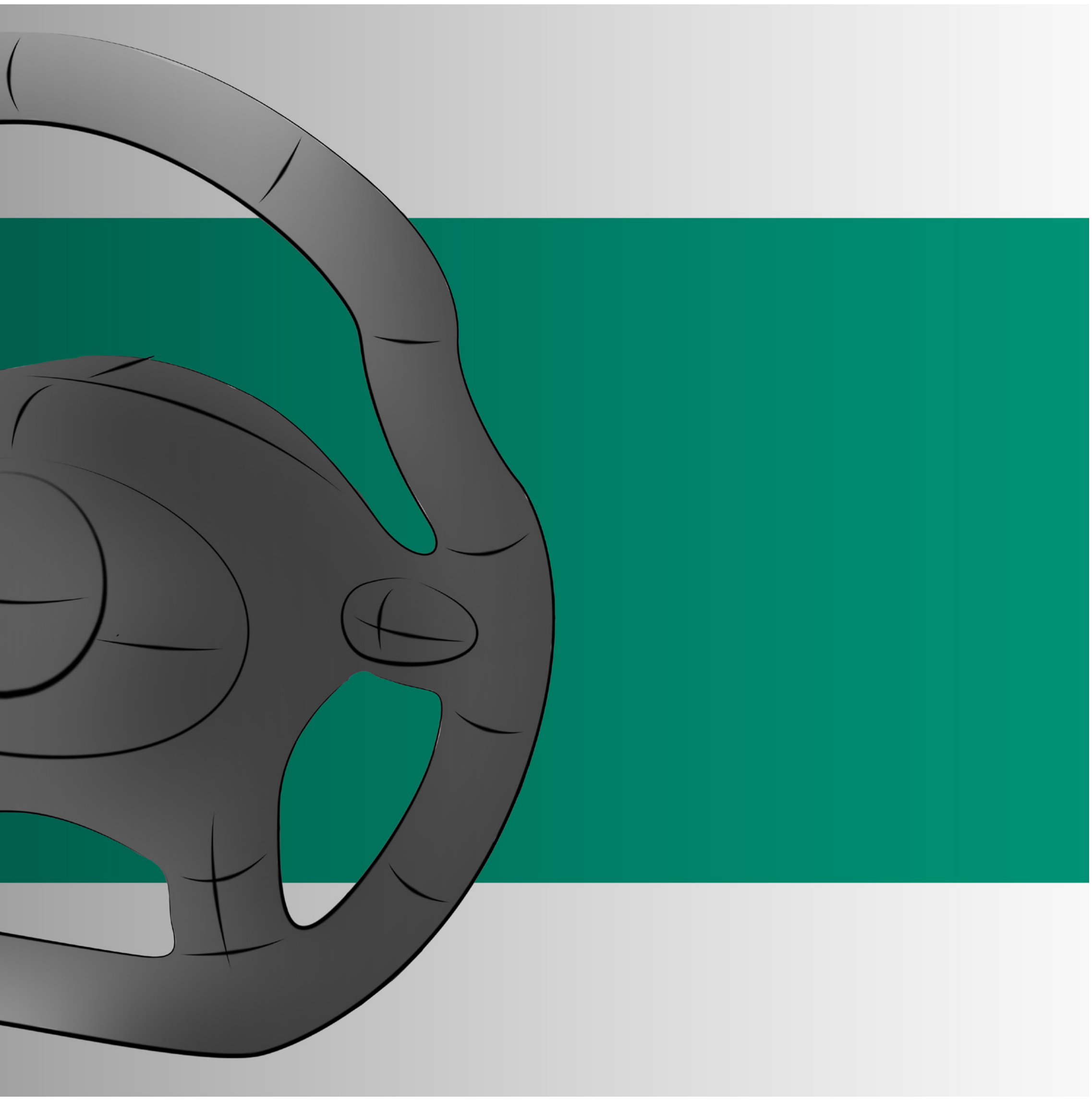


46. A preliminary sketch of Ippocrate (2015)

5. Concept

The concept of Ippocrate is something mixed by observation, design thinking and imitation of the existing products. In the first phase of the research i choose this topic, about a sensorized steering wheel. I thought there was a lack of focus on this field of project, the market is moving towards a high-tech focus design, but sometimes it goes in directions that are fashionable before than helpful. Observing some statistics, that are mostly explained in the previous chapter, i found an interesting poin: why not monitorate the driver while he's on the car? Why not take care of his health-status, his attention and activities in order to prevent accidents? I though it was interesting to investigate this field, improve the driving experience with ergonomic studies,



smart sensors and a re-shape of the entire object trying to make it more comfortable. Of course in this process i took many inspirations from other projects, from Toyota futuristic concept to BMW and its high-tech systems bu, not less, from past experience and that characterizing style that old-fashion designer used in their projects.

Designing is making something to help people, trying to improve their lifes and make the world a better place. This thesis tryied to to something in that direction, look at the users, empathize with them, designing for all of them.

5.1 Purpose of the project

In the previous chapters it's been analysed the history and evolution to portrait what kind of tool is a steering wheel and how much it changed during the years, in order to predict maybe where it will go; then there's been a focus on the driver and the environment, to make a storyboard-like experience of what is the world of steering wheel and car driving and choose some target to work for. All these aspects were taken in consideraton when i started to think about this projects. Ippocrate was born essencially like a interactive Steering Wheel, an active one actually. A smart object that could be not just something to move your car and let you do some minor activities, but also something that would have work for you all time along a drive experience.

Speaking about driving it came to my mind that driving is such a complicate activity. When we driver we are exposed, and we can feel safe just because a car is also made to fisically protect the driver. But some circumstances make it like a cage more than an armor, something which you can't escape from. Starting to think about this feeling i figured out how could i turn a car into a safety environment also in perception, so i took inspiration by the field of medicine. Here you can feel protected and safe, monitored during you recovery, there an attention to details, from shapes to colours, from interaction to environments in general.

The other problem was the huge lack of attention that driver's monitoring have in automotive fields. I made a research about projects that could maybe inspire me, drive me into particular way of thinking, but i found very few examples. One of them[34] is a safety steering wheel by Ford.

[34] From the article on "www.autoblog.com/2015/09/09/ford-car-health-monitor-patent/" written by Chris Bruce, 9th September 2015

This project now is just on paper, there's not even a prototype, but is based on the idea that driving and health-care must be linked together on the road in order to avoid very dangerous accidents. This steering-wheel will be smart enough, according to that idea, to recognize some parameters and maybe contact the paramedics and the ospital and stop the car in very dangerous moments. Doing something like this, deeply changing the spirit of an object that was born just for driving, it means that it changes also the approach to the entire object, from the shape to materials, from small details to choices about finishing or icon design. Everything is important to let the driver comunicate with the tool but also to make the tool able to work in the best way possible and for the longest time possible.

Another project based on a similar idea is being developed by Toyota[35]. This company is well know for being active in any fields of research and project conceptualization, it was one of the first to put their trust in hybrid technologies and electric cars, and now it's making investments on the field of health-care during driving. Toyota is working to broaden the safety envelope of its automobiles to protect not young or mid-age people but also elderly ones. Research suggests that half of automobile-related fatalities in Japan involve people aged 65 and over. Their concept wants to add cardiovascular monitors to monitor the driver. Grip sensors on the steering wheel are said to provide information of driver's cardio-vascular functions, designed to detect drivers at risk of collapsing at the wheel due to a heart attack or a sudden black-out. What, exactly, the vehicle's response would be was not explained, but Toyota said it has presented the idea to the Japan Medical Congress.
Taking some cardiovascular data and elaborate them could provide

Bibliographic Notes

[35] From the article "blog.caranddriver.com/toyota-previews-its-next-generation-safety-systems-including-a-cardiovascular-monitor/" written by Steve Siler, 3rd August 2013

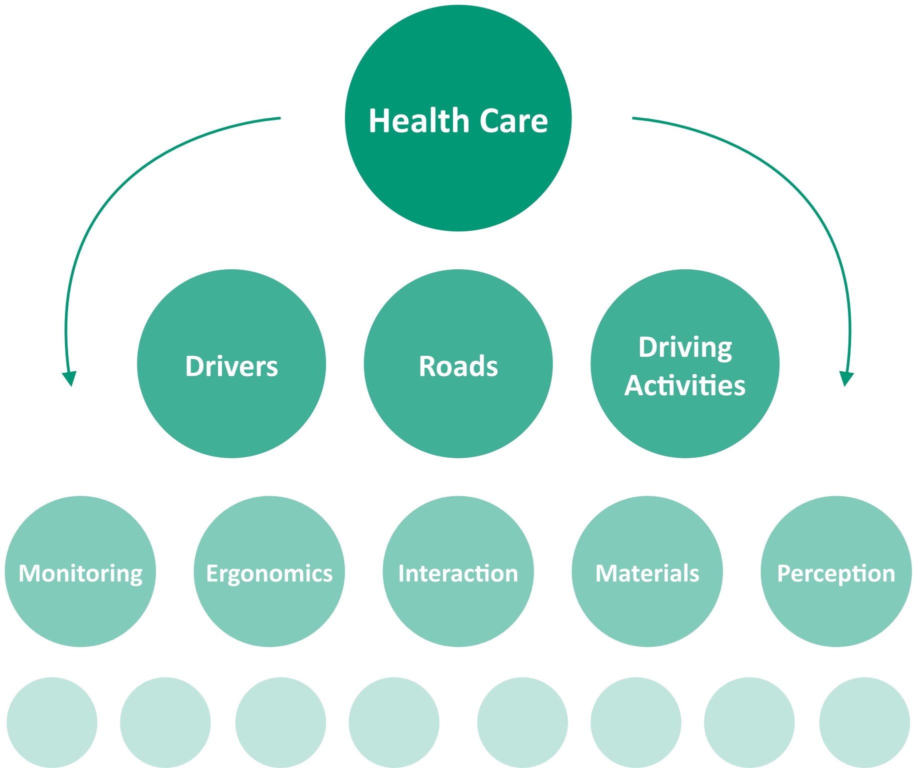
the on-board computer to predict if something is happening and act accordingly.

This is one of the main poin this thesis is about: looking at elderly people, more likely having disease or sudden illness, provide them a comfortable, well-shaped steering wheel, thought to be made of the right materials, very visible interaction features and sensors that can manage to take datas from them. Here is a list of the main factors take into account during the concept evaluation, divided by Categories:

OBSERVATION
- Look at drivers and their behviours
- Look at the environment
- Collect a list of notes about how they driver
- Read statistics
- Look at existing similar products and not similar too

ELABORATION
- Find problems to solve
- Evidence main problems and secondary ones
- Avoid redundancy and collect user's needs
- Find the main target or divide the targets into sub-groups

DESIGNING
- Think about one problem at a time
- Figure out how the problems could be solved and where
- Work on human factors and ergonomics
- Work on Interaction betweed product and users
- Work on the product's perception for the user



47. A scheme about the designing process made for Ippocrate in the first time

- Choose what parameters should be monitored

ENGINEERING
- Make the product manufacturable
- Put efforts on finishing and tactile feedback
- Make it cheaper as possible and conform to normative

In the image above you can see a sample of work-organization in the

Bibliographic Notes

first phase of the project.

Accordin to this method i proceed to make my first attempt to solve these problems and to move a step forward in the Steering Wheel designing. More details about this selection will be shown in the Chapter 6.

5.2 Monitoring the driver or the drive?

During the first phases of the project i decided to make Ippocrate an interactive steering wheel, a smart one. Then i had to choose between two different options, answering to these two questions: it's better to monitor the driving, how the car is moving and how is being used by the driver? Or is better to monitor the driver itself, his health status and his attention?

It was important to choose and it was not possible to take them both. In order to avoid redundancy as stated in the previous chapter and in the concept analysis. First of all, what means monitoring the driving and what the driver?

Monitoring the driving means to collect data from an activity. The activity of driving is intense, when we move with our cars we do many actions at the same time. Mercedes already use this methods on some of his cars: there are detection sensors on the front and the rear of the car that manage the traffic, the signals on the streets, pedestrian crossing, proximity and road markings in general. Matching these data collected by sensors and cameras the car is able to predicts with some approximation what could happen. If something wrong is probable, it warns the driver by shaking the steering wheel, a tactile output assisted by a sound warning. If there's not a modification in those parameters the car stops automatically, slowly, controlling the parameters. This kind of monitoring system is perfec when all the situation can be predicted with certainty. In case something is out of the model predicted by the software there's nothing the product can do to help the driver. There could be for example a situation where a car is following a long queue, maybe for an accident, and it crosses the lines on the streets many times. What will the program understand in this situation?

Could be better monitor the driver instead. For example about attention level. There are on the market many different kind of eyes tracking sensors able to detect their movement and predict, with a very high percentage, their level of attention. These sensors are also able to say if you are looking forward or you are distracted on something else (maybe the phone) and warns you if the parameters are out of a defined range. Then i thought about the possibility to monitorate the physical state of the driver, and also the alcool level in the blood. Inforomation and updatings about the physical status of the driver can provide a continuous feedback on the road, and this could be very helpful to elderly people, persons with various heart disease or glicemic disfunctions, people susceptible to epileptic seizures or sudden changes in blood pressure. In addition a biometric sensor capable of detecting alcool particles in the blood could stop the driver from taking the wheel and put in danger himself and the others. With all these datas you could be warned, and last but not least you can feel safe. The perception of the tools is important almost as his very functions, it can provide a better environment, a driving style more quiet and comfortable.

Bibliographic Notes

I chose to take care of you, driver, instead of your driving, because an activity could be manipulate, it depends from the situation. It can be predicted because it's the result of matching of many persons with their own behaviour. I think it's too semplicistic to put some high-tech features on a care and think that they can solve all your problems.

"if you give a man a fish he is hungry again in an hour. If you teach him to catch a fish you do him a good turn"[36]

We could pretend to protect the driver and give him utopistic, smart tools that will save him in many situation, but i think this is not the reality. This passage tought me that i should provide something that can help the driver, of course, but it's something that needs the driver to work in a better way, it's not self-efficient from some point of view, it's not a magic wand. It's like teaching him how to drive, putting his hands on the right place, saying to him that he's safe until he follow his status, checking all the parameters and paying attention to warning that the tool is smart enough to provide him.

5.3 Vital parameter

Human factors are a mix of ergonomics, reactions, interaction and vital parameters. This last word means all those parameters that can be listed when we speak about health-care in general. Vital parameters are uncountable, there are hundreds about just blood flowing, then others about chemichals in the organism, temperature, respiration. Usually, in medical fields, are called Vital Signs. We could list them to briefly exemplify how they could be various and how many signs is possible to detect wth sensors. Vital signs are used to measure the

[36] From the novel " Mrs. Dymond" written by Anne Isabella Thackeray Ritchie (1885)

body's basic functions. These measurements are taken to help assess the general physical health of a person, give clues to possible diseases, and show progress toward recovery. The normal ranges for a person's vital signs vary with age, weight, gender, and overall health. There are four main vital signs: body temperature, blood pressure, pulse (heart rate), and breathing rate.

Here there's a list made by the site of a clinic[37] in the USA (Cleveland):

- Body Temperature

- Blood pressure

- Pulse

In the next chapter there signs will be analyzed with two addiction: eye tracking and issues about old age.

5.3.1 Temperature fluctuation (fever or hypothermia)

The average body temperature is 36 degrees Celsius, but normal temperature for a healthy person can range between 35 to 37 degrees Celsius approximately. Body temperature is measured using a thermometer inserted into the mouth, anus, or placed under the armpit. Body temperature can also be measured by a special thermometer inserted into the ear canal. Any temperature that is higher than a person's average body temperature is considered a fever. A drop in body temperature below 35 degrees Celsius is defined as hypothermia. Keep in mind that temperature can vary due to factors

Bibliographic Notes

[37]From the article published on “www.my.clevelandclinic.org/health/healthy_living/hic_Pre-participation_Evaluations/hic_Vital_Signs”

other than illness or infection. Stress, dehydration, exercise, being in a hot or cold environment, drinking a hot or cold beverage, and thyroid disorders can influence body temperature. Because older adults do not control body temperature as well as younger adults, older adults may be ill without ever displaying signs of a fever.

5.3.2 Fickle Pressure (hypertension or hypotension)

Blood pressure: Blood pressure is the measurement of the pressure or force of blood against the walls of your arteries. Blood pressure is written as two numbers, such as 120/80 millimeters of mercury (mm Hg). The first number is called the systolic pressure and measures the pressure in the arteries when the heart beats and pushes blood out to the body. The second number is called the diastolic pressure and measures the pressure in the arteries when the heart rests between beats. Healthy blood pressure for an adult, relaxed at rest, is considered to be a reading less than 120/80 mm Hg. A systolic pressure of 120-139 or a diastolic pressure of 80-89 is considered "prehypertension" and should be closely monitored. Hypertension (high blood pressure) is considered to be a reading of 140/90 mm Hg or higher. Blood pressure that remains high for an extended period of time can result in such health problems as atherosclerosis, heart failure, and stroke. Atherosclerosis is also known as hardening of the arteries.

Factors that can influence a blood pressure reading include:

- Stress
- Smoking

- Cold temperatures
- Exercise
- A full stomach
- Full bladder
- Caffeine, alcohol consumption
- Certain medicines
- Gaining or losing weight
- Salt intake

5.3.3 Heartbeating ratio (bradycardia or tachycardia)

Your pulse is the number of times your heart beats per minute. Pulse rates vary from person to person. Your pulse is lower when you are at rest and increases when you exercise (because more oxygen-rich blood is needed by the body when you exercise). A normal pulse rate for a healthy adult at rest ranges from 60 to 80 beats per minute. Women tend to have faster pulse rates than men. Your pulse can be measured by firmly but gently pressing the first and second fingertips against certain points on the body - most commonly at the wrist or neck (but can also be measured at the bend of the arms, in the groin, behind the knees, inside the ankles, on the top of the feet, or at the temple area of the face) - then counting the number of heart beats over a period of 60 seconds. A faster than average pulse can indicate such health problems as infection, dehydration, stress, anxiety, a thyroid disorder, shock, anemia, or certain heart conditions. A lower than average pulse may also be a sign of a heart condition. Some medications, especially beta blockers and digoxin, can slow your pulse. A lower heart rate is also common for people who get a lot of exercise or are athletic. If checking your pulse, your pulse rate should not be routinely less than

Bibliographic Notes

60 beats per minute. The beats also should be equally spaced out, not excessively strong (would indicate a heart that is working hard), and no beats should be missed.

5.3.4 Eyes tracking

The last parameter that will be good to analyze is about driver's attention and eyes focusing. As stated in many of the previous points disattention is one of the most cause of accident in the whole statistics about car crashes. Distraction can be due to three factors: visual distraction, mobility distractions and cognitive distractions. Mobility distractions happens when the driver use improperly his hands, driving with just one of them or using them to make many different activities while driving. Cognitive distractions are due to mind flawing, when the driver lose his focus from the streets thinking about something else. While we cant's avoid the driver to use his hands in the right way or force him to focus on the street, we can warn him if he lose the visual concentration from the street. With an "Eye Tracker" could be possible to monitorate where the driver is looking at and say him if he's focused or not, if he's looking at the street or not.

This will be a perfect system to prevent accidents and reduce the risk of fatal crash due to distraction or dizziness. This is actually one of the most dangerous attitude on the wheel. A research[38] shows that the 37% of the interviwed drivers admit to have micro-sleeps, or head nodded conditions, while driving. It's a min point to work on, and could be possible just monitoring the visual status of the driver with infrared sensors and cameras mounted right in fron of him, on the steering wheel.

[38] From the article about sleep-deprivation written on " https://www.ergoflex.co.uk/blog/category/sleep-research/the-hidden-dangers-of-drowsy-driving" by Thomas Harrison, 2014

5.3.5 Issues due to old age

Elderly people are more common to be subjects to sudden disease for many reasons. They are physically weaker and fluctuations in their cases are much more common. As we've seen in the Chapter 4 elderly are becoming every year more independent and self-sufficient, the percentage of elderly drivers, over 65 years old, is increasing constantly, and it's willing to increase more in the next decades. On the other side elderly are responsible for a high number of accidents, due to their lack of physical capacities, concentration and reflexes.

According to researchs[38]:

3[39]

is the number of daily fatal accidents involving drivers aged 85plus

25%[40]

higher likelihood of elderly drivers to cause a crash afterperforming poorly on cognitive exams

35[41]

number of US states that do not require in-person renewals or revision exams for senior drivers

80%[42]

percentage of passenger fatalities in crashes involving drivers aged 70plus

600'000[43]

number of drivers each year aged 70plus who choose to give up driving

Bibliographic Notes

[39] Taken from "USA today"

[40] From the "Journal of American Geriatric Society"

[41] Statistics taken from "Insurance institute for Highway Safety"

[42] From an article on the "American journal of Public Health"

All this datas describe a very critic situation for elderly, sometimes unable to protect themselves from casualties. The last data is pretty impressive. It proove that there's a lack of confidence for elderly towards the whole automotive fields, they feelds merely abandoned to their own. This situation is anyway exacerbated by the physical and mental status of elderly. Even if they are in healthy condition thery are more subjected to distractions and they have les reflexes to react sudden events, and in addition an old person is more likely not to survive an accident due to the less strength about injuries. The reaction time of an elderly person over 65 years old is about twice the reflexes of a 20 years old person, and in general passing the mark of the 50 years a person hugely increase his reaction time. In addition there are problems about depth perception, an elderly perceive distances lower or higher depending on which kind of disease does he have. At last there are high probability for an elderly to feeling nervousness and anxiety, easily going in tachycardia.

All these point are likely to be solved with monitoring and reshaping, working on ergonomics and human factors. With few parameters to monitorate we could have on our tool a good portrait of the situation, make it visible, warn the old driver and in general giving him the perception that even if he's in good healthy condition, if something happen he's not alone, there's something that is helping him actively and constantly.

5.4 Interaction Design

In the whole design fields Interaction is one of the most developing aspects in the early 2000s. together with the improvement of objects and their willing to become smart, the importance of making them easy to use for the user is becoming primary. Actually there are objects that have almost zero design and a hundred percent of interaction, for example Smarphone or GPS systems. They are very simple objects, made essencially as a screen as thin as possible, filled with visual features designed to be user friendly. This goes in the field of App Design and Web Design, the planning of something that is just virtual. Ippocrate features some functions that exploit interaction design and app design. Thanks to the project produces during the Erasmus experience in the course "Iinteraction Design - Bringing the gap" taken by Professor Wolfgang Gauss i worked on the development of the application for Ippoctare, useful to manage the sensor's datas from the physical tool. Interaction must be something adaptive to the user, able to perform all its features clearly and avoiding redundancies. In this topic has been very important the attention to details, the icons design, their dimensions and colors, the wireframe of the application, the dimension of the screen, the general organization of the app with sub-menues. About this topic it has been produced a conceptual map, that will be shown in detail in the next chapters, useful to visualize how the user will be able to maange the App.

Iteraction design principles can be resumed in this way:

Define How Users Can Interact with the Interface: what can a user do with their mouse, finger, or stylus to directly interact with the interface? This includes pushing buttons, dragging and dropping across the interface. What commands can a user give, that aren’t directly a part of the product, to interact with it? An example of an “indirect manipulation” is when a user hits “Ctrl+C”, they expect to be able to copy a piece of content.

Give Users Clues about Behavior before Actions are Taken: what about the appearance (color, shape, size, etc) gives the user a clue about how it may function? These help the user understand how it can be used. What information do you provide to let a user know what will happen before they perform an action? These tell users what will happen if they decide to move forward with their action. This can include meaningful label on a button, instructions before a final submission, etc.

Anticipate and Mitigate Errors: are there constraints put in place to help prevent errors? The Poka-Yoke Principle says that placing these constraints forces the user to adjust behavior in order to move forward with their intended action. Do error messages provide a way for the user to correct the problem or explain why the error occurred? Helpful error messages provide solutions and context.

Consider System Feedback and Response Time: what feedback does a user get once an action is performed? When a user engages and performs an action, the system needs to respond to acknowledge the action and to let the user know what it is doing. How long between an action and a product's response time? Responsiveness (latency) can be characterized at four levels: immediate (less than 0.1 second), stammer (0.1-1 second), interruption (1-10 seconds), and disruption (more than 10 seconds).

Strategically Think about Each Elements: are the interface elements a reasonable size to interact with? Alements, such as buttons, need to be big enough for a user to be able to click it. This is particularly important in a mobile context that likely includes a touch component. Are edges and corners strategically being used to locate interactive elements like menus? Fitts' Law also states that since the edge provides a boundary that the mouse or finger cannot go beyond, it tends to be a good location for menus and buttons. Are you following standards? Users have an understanding of how interface elements are supposed to function. You should only depart from the standards if a new way improves upon the old.

Simplify for Learnability: is information chunked into seven (plus or minus two) items at a time? George Miller found that people are only able to keep five to nine items in the short-term memory before they forgot or had errors. Is the user's end simplified as much as possible? Tesler's Law of Conservation notes that you need to try to remove complexity as much as possible from the user and instead build the system to take it into account. With that said, he also notes to keep in mind that things can only be simplified to a certain point before they no longer function. Are familiar formats used? Decision time is affected by how familiar a format is for a user to follow, how familiar they are with the choices, and the number of choice they need to decide between.

According to these principles explained by professor Gauss i produced an application that is easy to use, designed on user's dimensions, with immediately recognizable icons, a warning time and parameters shaped on driver's expectations,

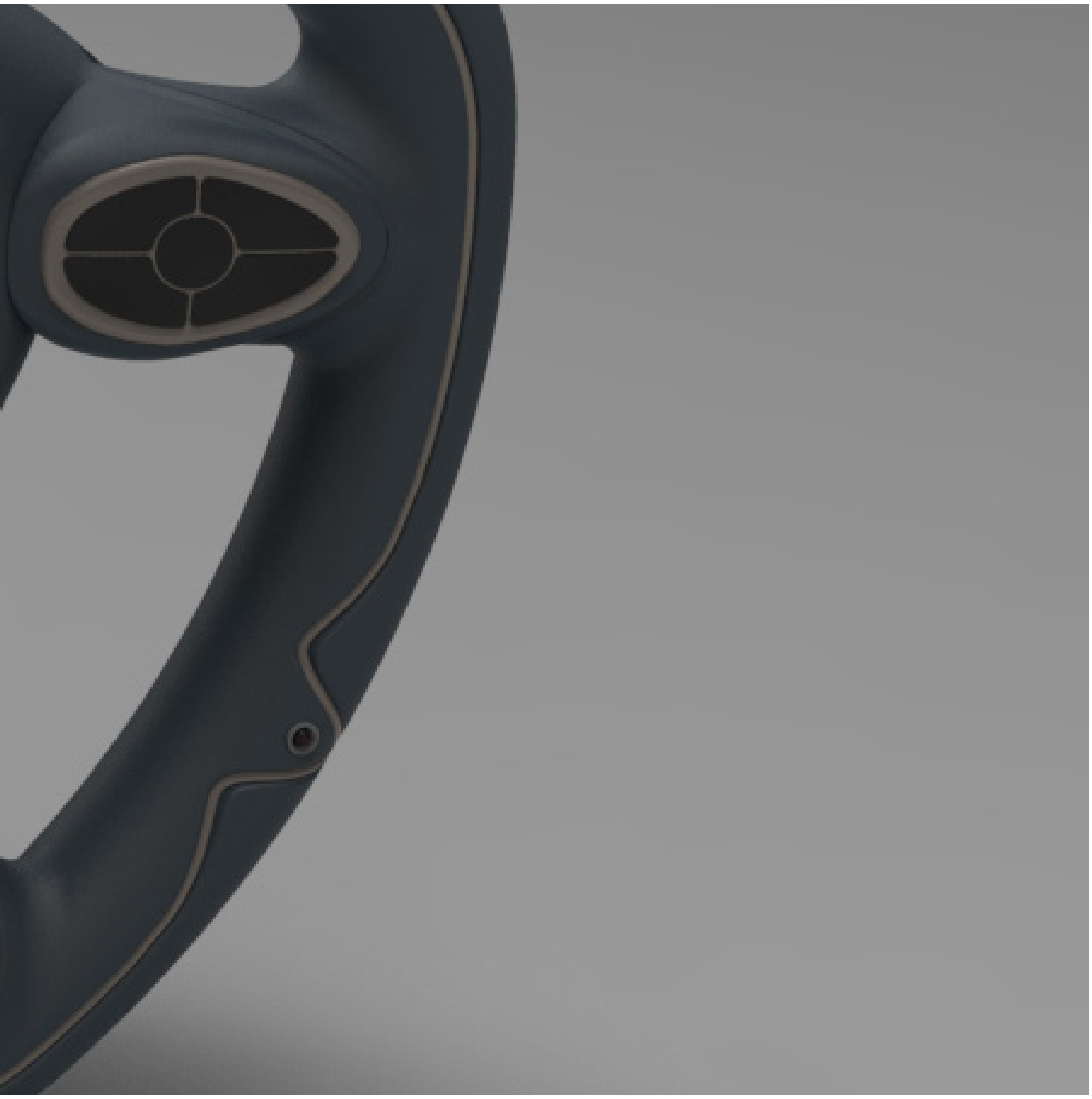
Bibliographic Notes

48. A raw modelrendering of Ippocrate (2015)

6. The Project: IPPOCRATE

This chapter will finally explain Ippocrate in all his parts, together with a focus-on chapter on the App and one on the sensors. There will be some paragraphs about the Name and the Logo, the Benchmarking and the general inspirations for its Design, some focus on the Shape, Ergonomics, Materials, Colors, it's general functions.

Everything will be explained with details and with the help of raw renderings and in-environment ones. Ippocrate was born with the intention of making not just something high-tech, or just well-designed, but a product with an identity, something that needs few words to be explained, something that can seems archetypical in some ways.



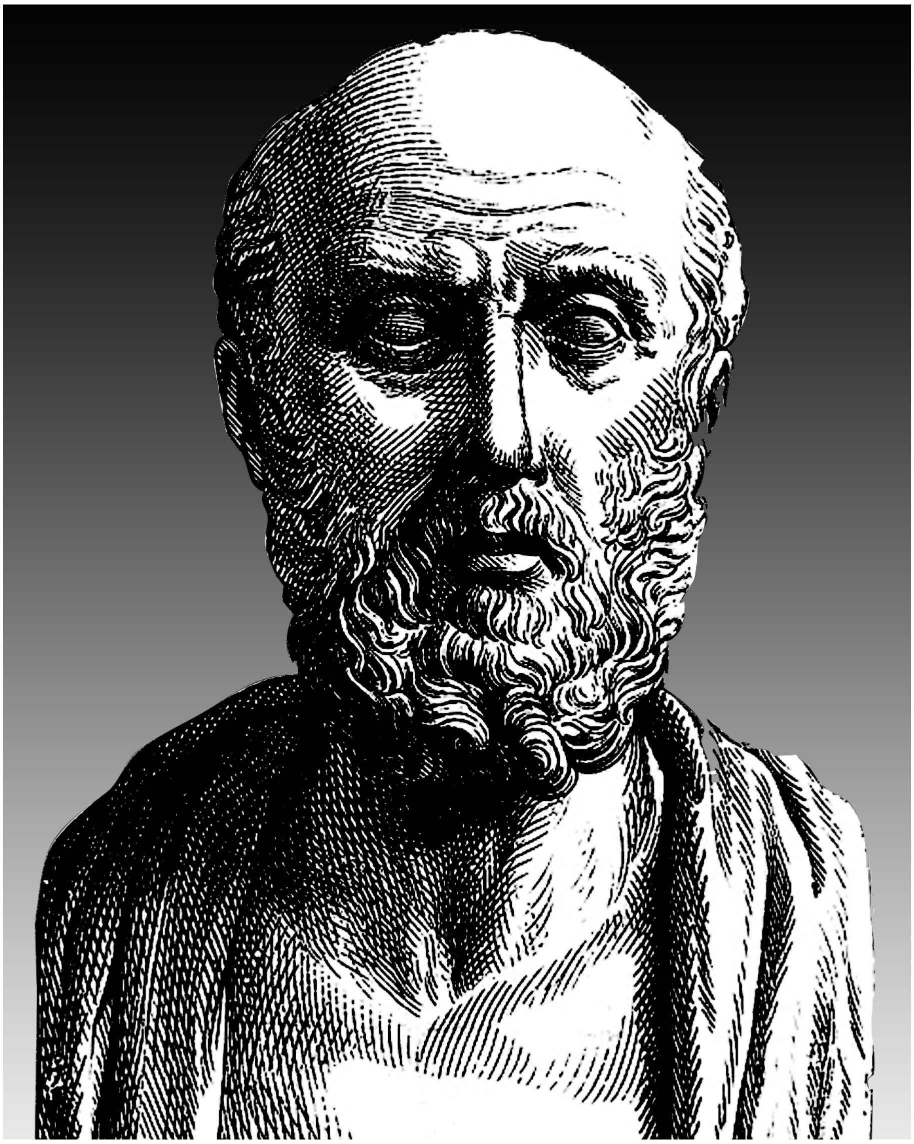
All the design choices you will find in this ex-cursus were made going in this direction.

6.1 The name and the Logo

Ippocrate is a projects about a Steering Wheel, an object that is pretty much linked to the concepts of high-tech or ergonomics. According to my research it was never linked to the medical fields before, except some timid attempts. Ippocrate is very linked to medical sciences, but not secondarily to medical languages. The shape is inspired to that world and we'll see that in the next paragraphs, but from the name itself i've been ifluenced by medicine.

Hippocrates of Kos was a Greek physician, he lived during the Age of Pericles (around the 400 B.C.), but he's most known for being one of the most considered figure in the history of medicine. He's referred as the father of modern "Western Medicine" and he's the founder of Hippocratic Medicine Schools that revolutionized medicine splitting it from other sciences that were considered on the same application fields like Theurgy or Filosophy. I chose to take his name, in Italian language, because i find him an inspiring figure, that tryied to fight for his belief and with his foresight won over the customs of his age. In a reverse inspiration process i chose to match two different disciplines like medicine applications and automotive industry because i believe that in our time it's important, when it's possible, to make very different subjects collaborate to create something new, unexpected, like Hippocrates did while he suggested to make of the medicine a separate area of study and applications.

From medicine fields i've been inspired also for the creation of the Logo. I took it from the Greek mythology, the Rod of Asclepius. Also known as the Staff of Asclepius is a serpent-entwined rod wielded by



49. An Hippocrates illustration of Kos bust (1922)

Bibliographic Notes

the Greek god Asclepius, a deity associated with healing and medicine. The symbol has continued to be used in modern times, where it is associated with medicine and health care, yet frequently confused with the staff of the god Hermes, the caduceus. I chose it as a symbol in the name of the project and in the logo too for the App, but i wanted it to be more minimalistic, so i redesign it making it smoother, less detailed and more recognizable for instance. When you turn on the App on the device it compares the pushable logo, so i tryied to make it icon-stile. In these page you can see the Rod of Asclepius as used by U.S. Army Medical Corps Branch Plaque (in 1902 the caduceus was added to the uniforms of Army medical officers). On the right page is the construction scheme with the wireframe for the logo itself, with no colors.

50. US Army medical deparment Logo

51. The Wireframe Structure of Ippocrate's Logo (2015)

Bibliographic Notes

6.2 The Functions and the Targets

Ippocrate is a new Steering Wheel system designed to be ergonomic, reassuring, with monitoring features thoght to be helpful for anxious people, elderly people or in general for those who have some issues or disease, not bad enough to prevent them from driving but enough to be a problem in some cases. The first prototype that you can see in on the right had some problems: it was not so much ergonomic, i think the circle shape is to much geometrical and force the driver to keep the hands vertical, not giving him a safe grab on the wheel and in addition it fatigues his shoulders for long trips. This wheel is made also for elderly, ergonomics is very important and make something that is easy to use and it's not hard for the physique is a primary purpose. The second factor was the disposition of the sensors: you can see now six sensors as before. Following the clock-disposition, before they were put on 10-2, 9-3, 12 and 6. Now are on 10-2, 8-4, 12 and 6. I found, according to some statistics i wrote in the previous chapters, that you people are used to drive with one hand in the top-middle, adults usually put the hands on top-side and elderly on bottom-side or bottom-middle. The best grabbing position are on 8-4 and 10-2: in the first case tou can rest your arms and shoulders and have a great control over your vehicle, in the second one you have the best control but you fatigue your limbs in long trips. I've put the sensors also in the middle becuse i think it's not possible to force people to move them in the proper area, so it's better to sensorize also those area in order to have a bigger range of monitoring map. I also found, making a model, that the two depression in the 10-2 area that nowadaysyou can find on many steering wheel are pretty uncomfortable as they are, instead of those i made two structural depressions in order to force your wrists

52. The first attempt to design Ippocrate (2015)

to be more horizontal instead of being vertical and obstructed by those two shapes. The flat part of the ring in the middle is made to save space for taller ones and to give a safe rest zone, most of all for elderly, while driving for example in long queues. I also moved the camera (that now are two, in order to sensor not just the movement of your eyelids but also the sight direction) from the top-midde to the central part of the wheel: in this way ther are much less moving while turning and they are more precise.

In the next pages are some comparisons between the older version, similar to standard ones, and the new one, with a reshape of the outer ring and a redisposition of sensors and camera. You will find some differences in wrists position and sight direction

Bibliographic Notes


53. The final Ippocrate project well-grabbed with resting wrists (2015)

6.3 The shape

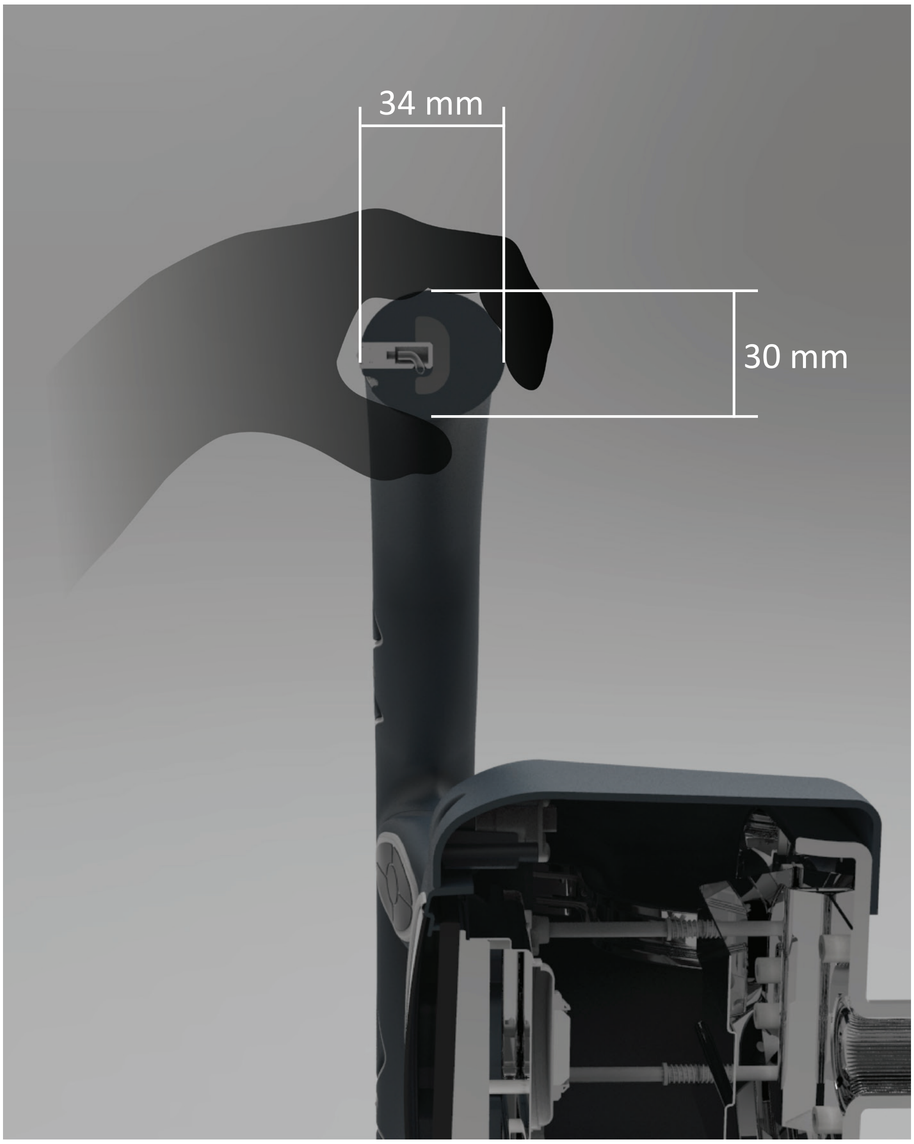
On the left (img 53) you can see that the shape of the outer ring help the driver to keep his wrists more aligned to the arms making the driving position much more comfortable than the older project (img 54). The two depressions on the left image are inclined, in the first tangent curvature, with an angle of approximately 45 degrees. This angle allow the driver to mantain his elbows in a resting position leaning on the body. With this modification the driver can less fatigue his shoulders, he can avoid his wrists to be to much twisted having, in general, a better control over the vehicle. Moreover in this way, speaking ofproduction processes, having a continuing section is much cheaper than a variable one contributing to decreas the production price.

54. First Ippocrate with comfort issues like standard steering wheel (2015)

Notes

Not only the profile is shaped to be comfortable, also the sections are thought to be well-graspable with hands. Instead of having a circular section to grab, i studyied the hands conformation and, looking at modern steering wheel, i found that an elliptical section is better to grab. Elliptical is better because human's phalanges are not all the same length in the hand, the first section of three is longer than the other two taken one by one, but shorter if compared to their addition. For this reason, as you can see in the next page's image, the ellipse is made to have its short diagonal longitudinal towards the wheel and the longer one perpendicular to the main plane. In this way your first phalanges will be on the short diagonal and the other two will adapt along the longer diagonal segment of the ellipse allowing the driver to always have a good grab on it (ergonomics references at page 63).

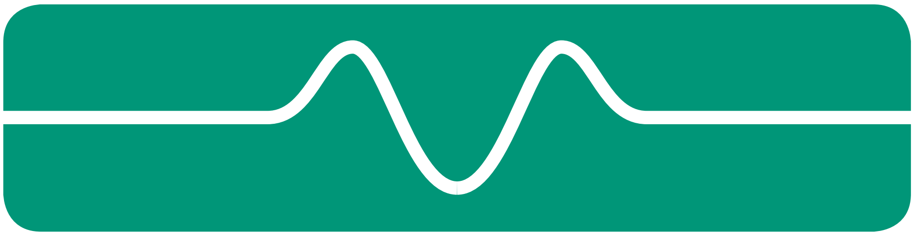
55. A section of the outer ring to show the elliptical shape of the part (2015)



6.3.1 Grabbing parts

The parts is made of the outer ring itself just in one piece, produced by reaction over-injection moulding of Polyisocyanate on the main structure made of Aluminium. As you can see on the right image this method grant a perfect assembly between the parts and there's no way to remove it except cutting it out. This has value also for the threaded insert, where will be installed the sensors, and the pipes where the cables will pass through during the assembly process. On the outer part of the ring, in the front of the part, there is a all-round carving line. That line will be filled with a rubber O-ring and glued on the main part without possibility to remove it. That prt it's just a simply decoration, but maybe it's not just a mere ornament. It' designed to make the

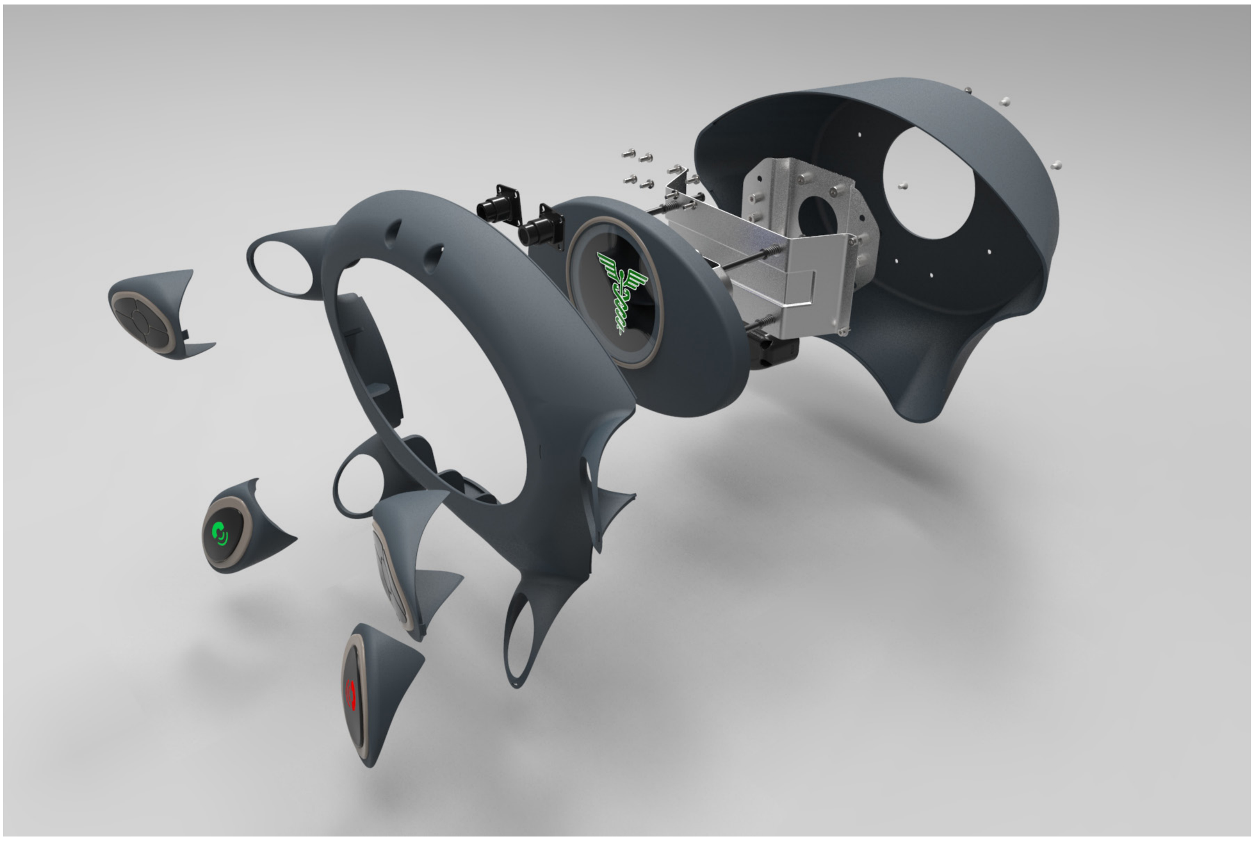
56. The assembly between the aluminium structure and the Polyisocyanate cover molded on it (2015)



57. The line carved on the outer part of the wheel (2015)

Notes

steering wheel recognizable, with a strong identity and a personality. The inspiraton for that line came up from the medical fields, again. It's made to resemble to the drive the achocardiogram that perform your heartbeating during a medical examination or a monitoring test. Of course is a semplifyied line, it's not realistic and it's minimal as all the project claim to be. But it's iconic, that irregular, sinusoidal trend has become something with a strong connection to medical fields. Up in this page you can find a partial section view of the grabbing part of the steering wheel and the line made up to be carved on the ring itself. The sensors and on-wheel commands will be added in a second time after they are pre-assembled on a different assembly-line. The sensors will also be mounted after the production process of the outer parts such as all the internal componenst and the external covers.

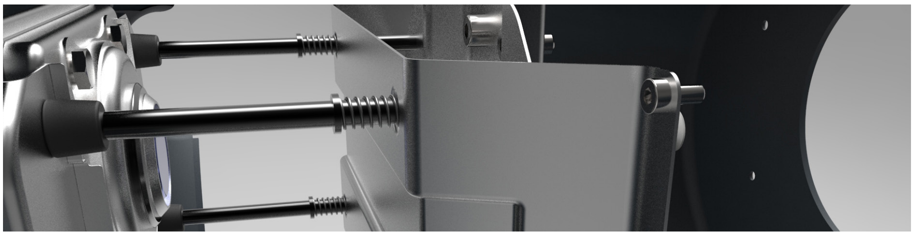


58. *(On top) Exploded view of the central parts*

59. *(on the right) Particular of the internal parts*

6.3.2 Central Parts

The central part of Ippocrate is essencially made of two shells and many parts assembled on them, like the hand-wheel commands, the Air Bag system system, the screen, the two cameras and the internal parts. The outer covers are made of ABS and produced with injection molding. They present various reinforcement over the profile when necessary, like in the frontal cover. The sub-assembly process claim to be something to speed up the whole process of assembly: first of all are assembled the four hand-wheel commans and then are mounted on the frontal cover. Then it's the turn for Air Bag system to be mounted on the central cover that wull be put on place thanks to its brackets mounted on the sheet metal structure previously screwed



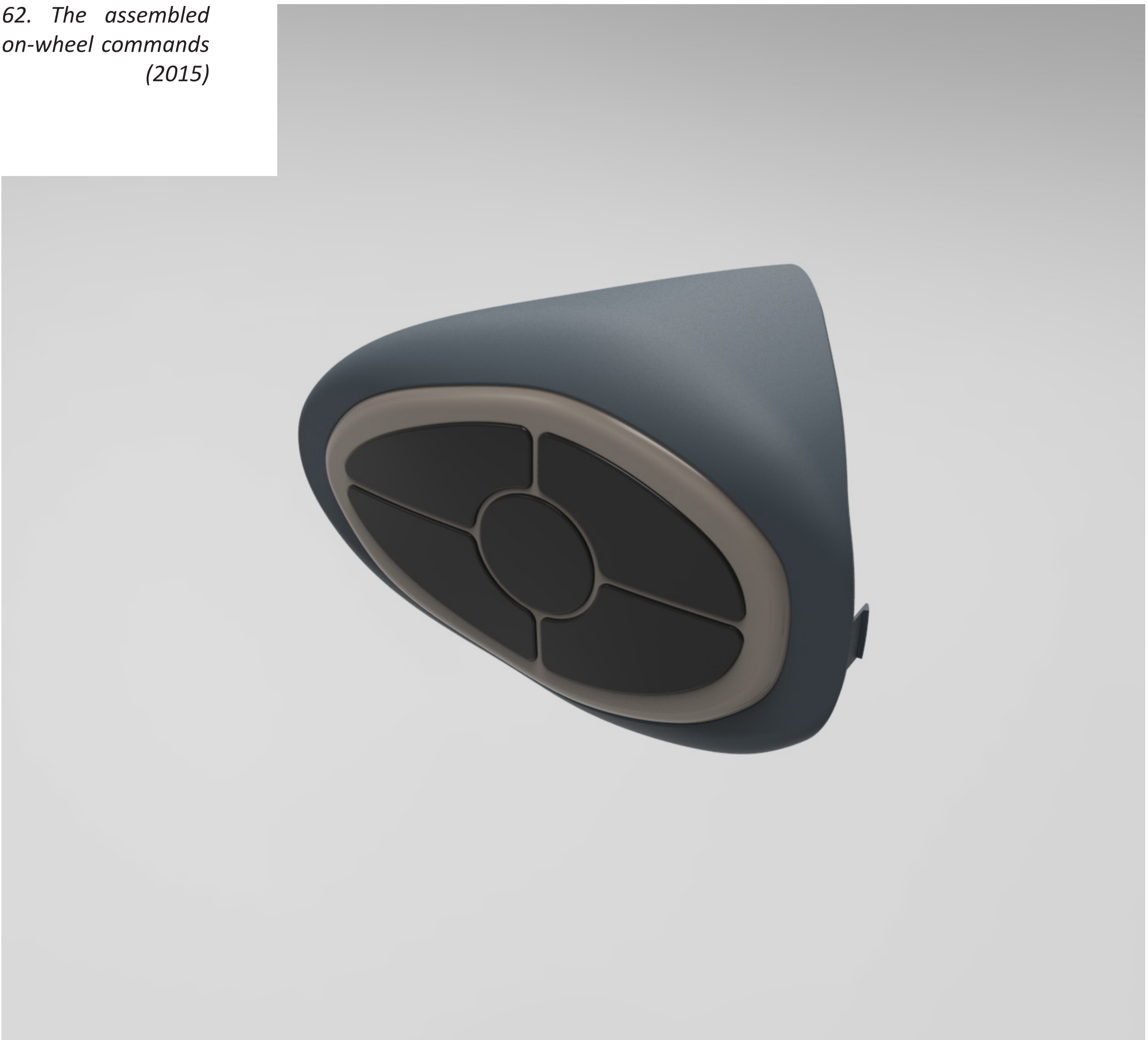
60. (on top) The three main parts of the central assembly

61. (on the left) A particular view of the inside parts

Notes

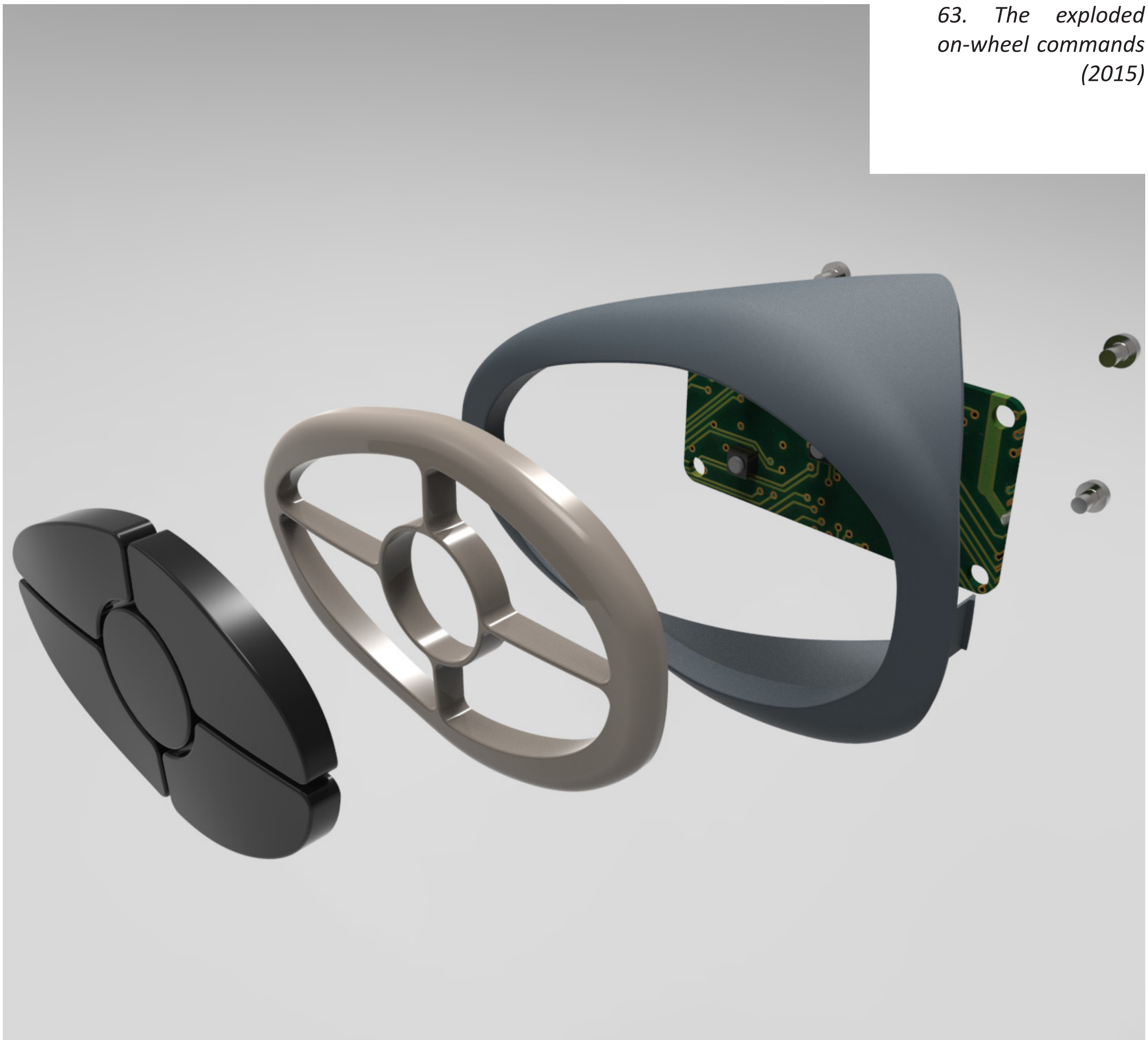
on the Aluminium structure of the entire steeering wheel. Finally it will be mounted the back shell, in ABS, useful to cover the internal parts nd protect them. There will also be the electric box, made of polycarbonate, where will be assembled the electronic boards. These parts are assembled thanks to geometrical joints and snap-fits with a particular attention to reduce the use of screws and bolts. The general style of these parts is roundy, made to be not to much aggressive to the driver because is thought not just for young people but also, or mostly, for elderly ones. The central part is ellittical, the four spokes are roundy and the whole central assembly features curves and smooth lines. The two buttons for answer a phone call or hand it up are pretty big in order to make them much visible, not distracting the driver and let the elderly have an immediate availability when using this function.

62. The assembled on-wheel commands (2015)



6.3.3 On-wheel Commands

The commands on the wheel are one of the sub-assembly of the device. The main cover, in blue in the two images on top, are made of ABS and produced with injection molding. They are mounted on the main cover of the wheel with some snapfits in order to simplify the assembly process for the installers. On this part is assembled the external frame, in grey in the images, made of polycarbonate and produced in injection molding. After that is the turn for the buttons, in black, made of polycaronate and produced in injection molding, ending with the assembly of the electronic board screwed on the external cover. This assembly process occurs before to mounting all this group on the steering wheel, just after to process these part it will



63. The exploded on-wheel commands (2015)

Notes

all mounted on the main cover of the steering wheel with the snapfits joints. I avoided to put the functions on these buttons in order to let the car company chose what to put on, depending on the equipment package chosen for the car itself. The buttons are pretty few and big, avoiding the redundncy of functions and making them very visible while driving. The shape follow the style of the whole project. With roundy choices and elliptical shapes i wnted to make it smooth and not to much aggressive for the target i chose.
The position of these commands has been chosen following exampes actually used on car, putting them in place of the crossing between the central part and the four spokes. In this positions you can have access to the commands if you drive with your hands in high position while you have the control of the phone answering with hands down.

64. Sensors' areas made on evidence on the steering wheel

6.3.4 Sensors position

The sensors' position was chosen to let the driver mantain his favourite driving posture but also to drive him to the most comfortable positions for hands and shoulders. As you can see in the images above the six areas where you can put your hands while being monitorate are on an hexagon vertices, in this way there's the necessary simmetry to allow the user to drive always with both his hands.

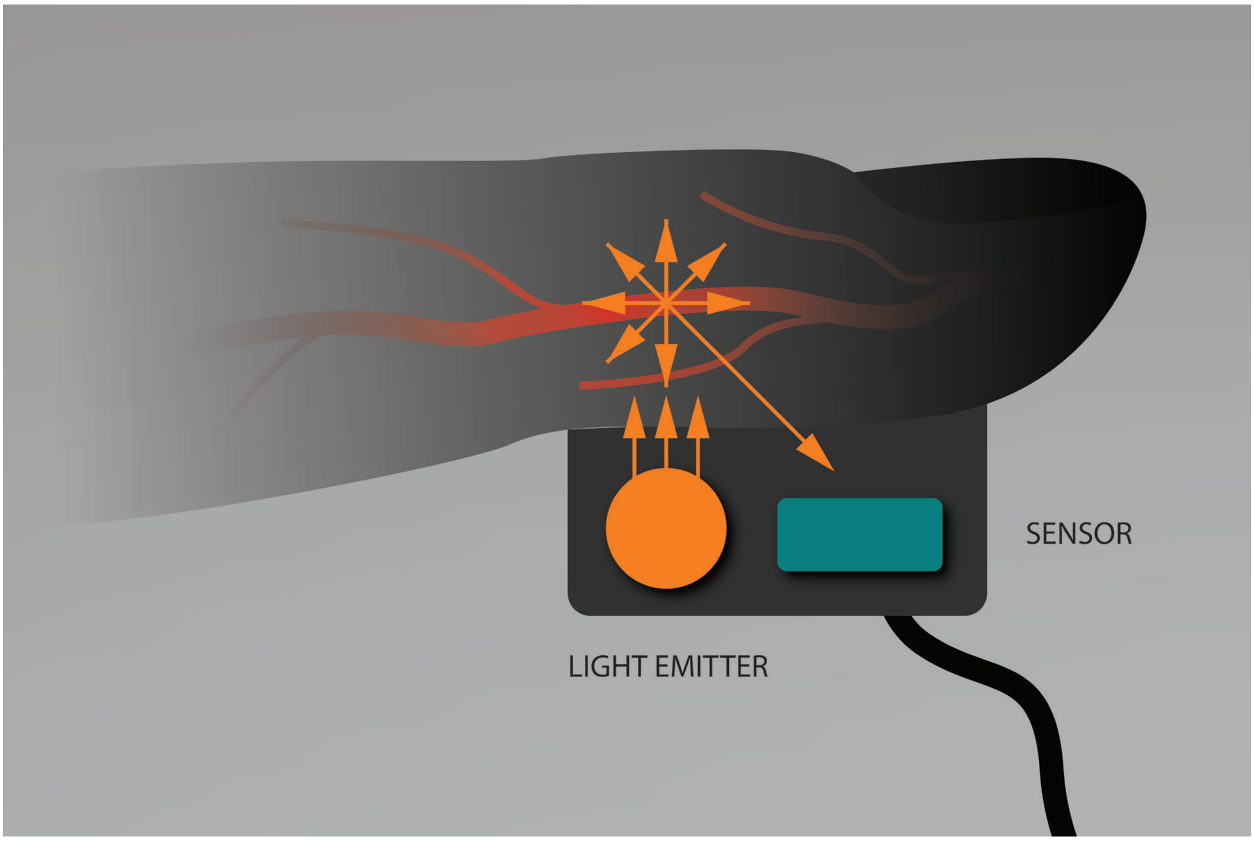
As you can see in the image 65 this shape is made to let your wrists as aligned to your arms as possible to let you rest them. The two sensors in the middle are not recomended for a safe driving but in some occasion they could be useful enough, for example while driving in a long queue

65. Some driving position of your hands while driving with Ippocrate

Notes

passing a borderline or driving in main highway. In general, most of all for the middle-bottom area, it should be recomended to use it just in case there are not many curves to deal with when on the opposite side you should drive with hands on 10-2 position or 8-4 position.

The central part is pushable and it contains the horn function and the app-screen that will be described later. What's important to be monitored in a suficient way is to keep, at least, one hand on one of these sensors. This configuration goes in that way, trying to cover the most possible positions for the driver, avoiding to be to much dispersive and making all the possible configuration comfortable enough for a safe drive. Also the flat part on the bottom is made to grant to the driver enough stability and control in those situation he needs to rest.

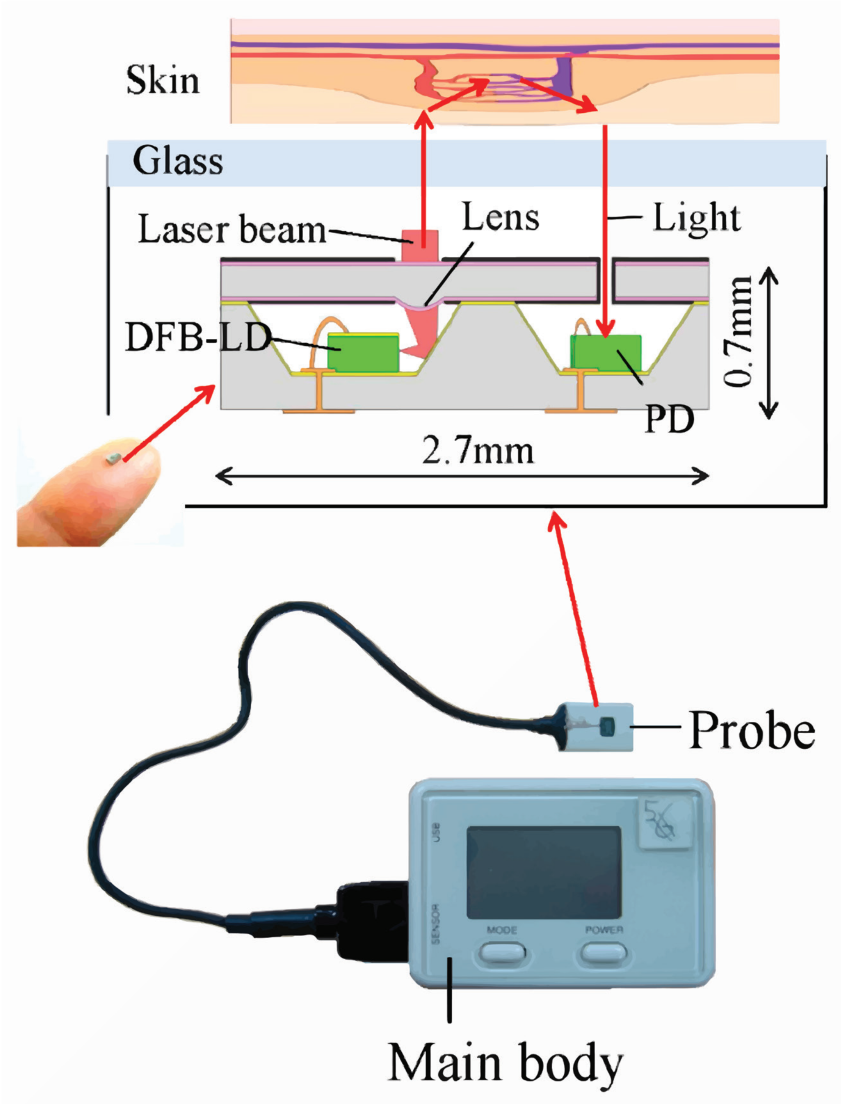


66. (On top) A scheme of how photo pethysmography works

67. (on the right) Optical sensor

6.4 Sensors

On Ippocrate are mounted six sensors and two cameras to detect parameters to use for driver's health-care. These sensors are all the same one, optical sensors using photoplethysmographic technology to see how the blood flux is moving in the user's body detecting Pressure, Pulse and Temperature. A light source in the transducer transilluminates the finger tip, and a photoconductor detects changes in light intensity within the finger caused by pulsatile variations in blood volume. Plethysmography is the most widely used measurement technique for assessing peripheral blood flow. The technique is based on the differential light-absorbing characteristics of tissue and blood. Specifically, living tissue is relatively transparent to light in the infrared



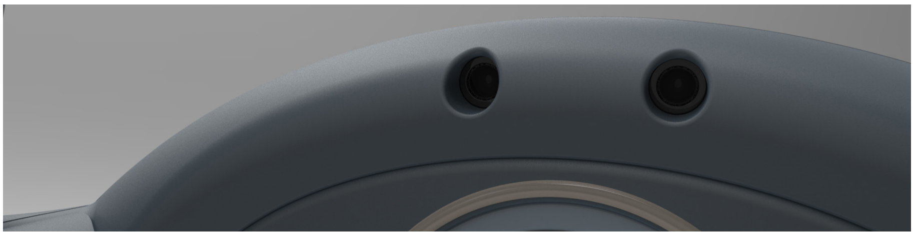
68. An example of photo plethysmographic sensor working on the skin

Notes

range, whereas blood is relatively opaque to light within this frequency range. Blood pressure results from two forces. One is created by the heart as it pumps blood into the arteries and through the circulatory system. The other is the force of the arteries as they resist the blood flow. Wearable wireless physiological sensors are helpful for monitoring and maintaining human health. Blood flow contains abundant physiological information but it is hard to measure blood flow during exercise using conventional blood flowmeters because of their size, weight, and use of optic fibers. To resolve these disadvantages, some companies developed a micro integrated laser Doppler blood flowmeter using microelectromechanical systems technology and actually they attempted to measure skin blood flow at the forehead, fingertip, and earlobe of seven young men while running

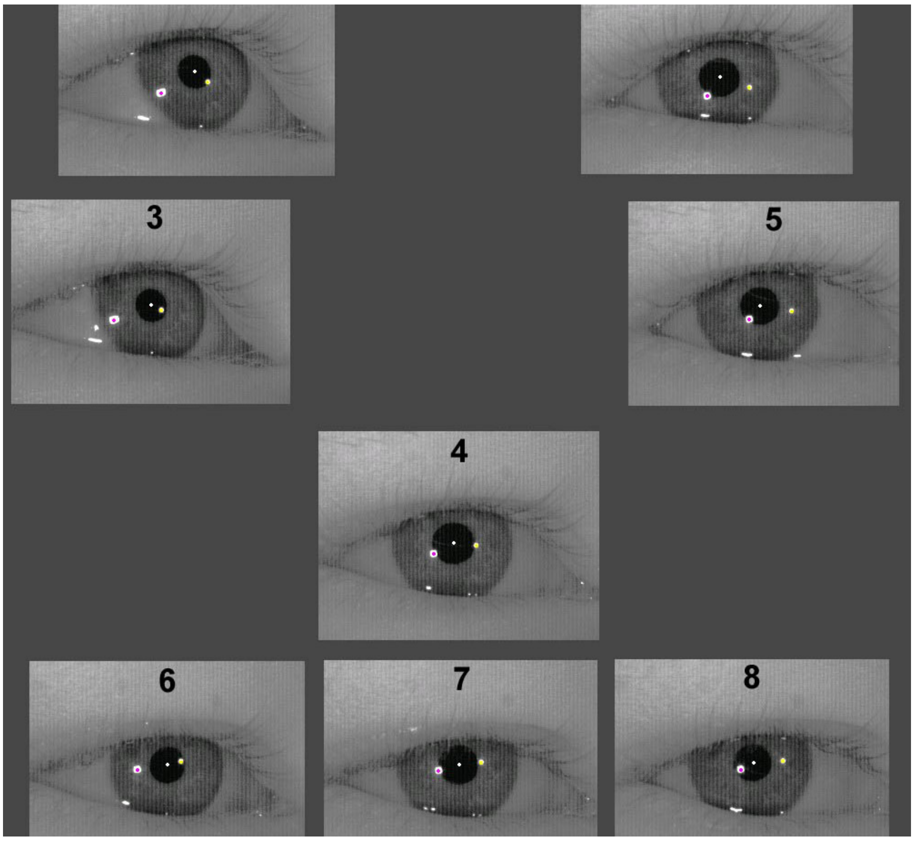
69. *The two detection cameras mounted on the frontal cover*

70. *The two detection camera as seen from the front*

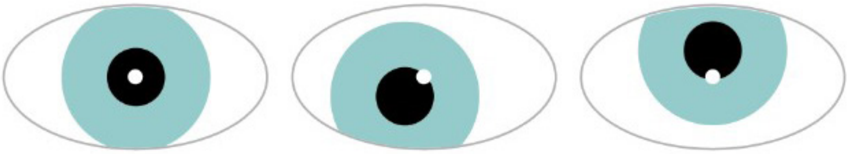


6.5 Eyes movement detection cameras

Eyes tracking is a technology that allow the device to catch information from the user's eyes and detect the sight direction and other informations. Light, typically infrared, is reflected from the eye and sensed by a video camera or some other specially designed optical sensor. The information is then analyzed to extract eye rotation from changes in reflections. Video-based eye trackers typically use the corneal reflection (the first Purkinje image) and the center of the pupil as features to track over time.
The corneal reflection is that kind of light-spot you can find on the eyes when a light source is shining in front of them. That spot is actually moving together with the sight direction of the person itself.



71. Some photos about a corneal reflection test. In white circled red is highlighted the reflection



72. A scheme of how corneal reflection detection works

Notes

Measuring that reflection-relative movement is possible to detect where is the person looking at. In addition to the corneal reflection detection there is also the pupil eye tracker able to extract from the black pupil a surface-3D model of it and analyze where it's looking at.

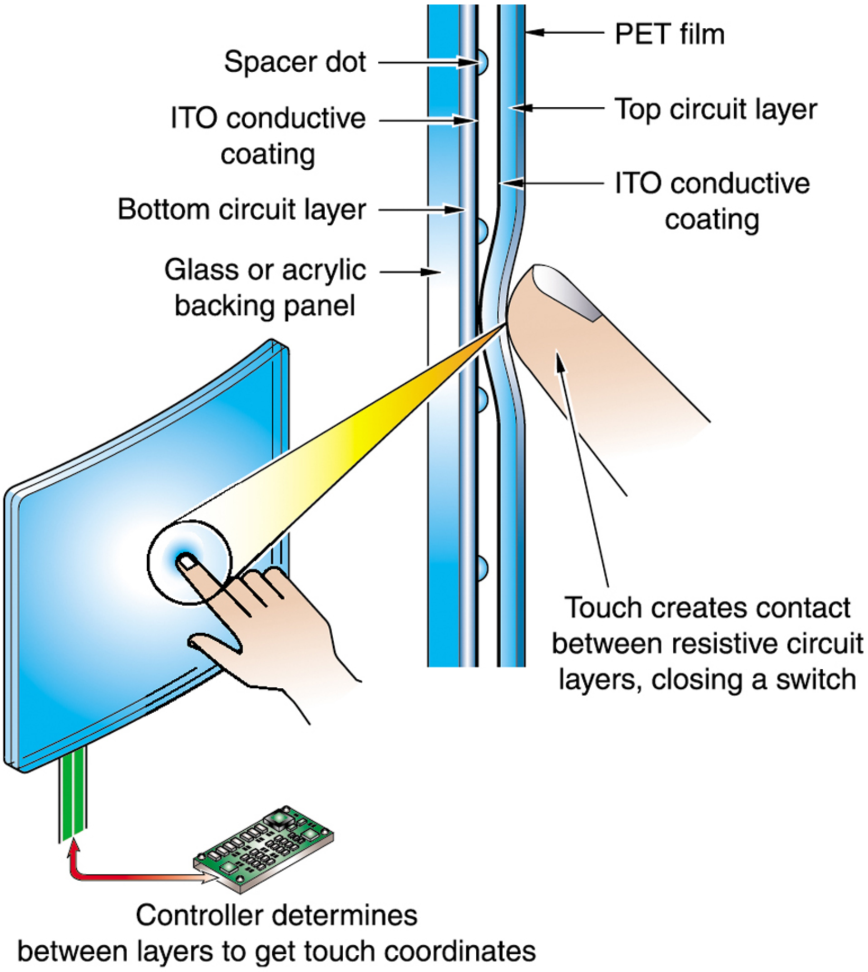
This is useful in driving monitoring to predict distraction and probable accident or prevent drowsiness accidents. On Ippocrate are mounted two cameras able to detect all these parmeters, translate them and put the results on the screen.
In addition this device warns the driver when he's getting physically distracted or just moving his eye-sight from the street to somethin else. I thought of a percentage of attention to put on the screen as you will see in the last chapter about the application.

73. The location of the screen seen from the front

74. An exemple of a user-screen interaction

6.6 Resistive touch screen

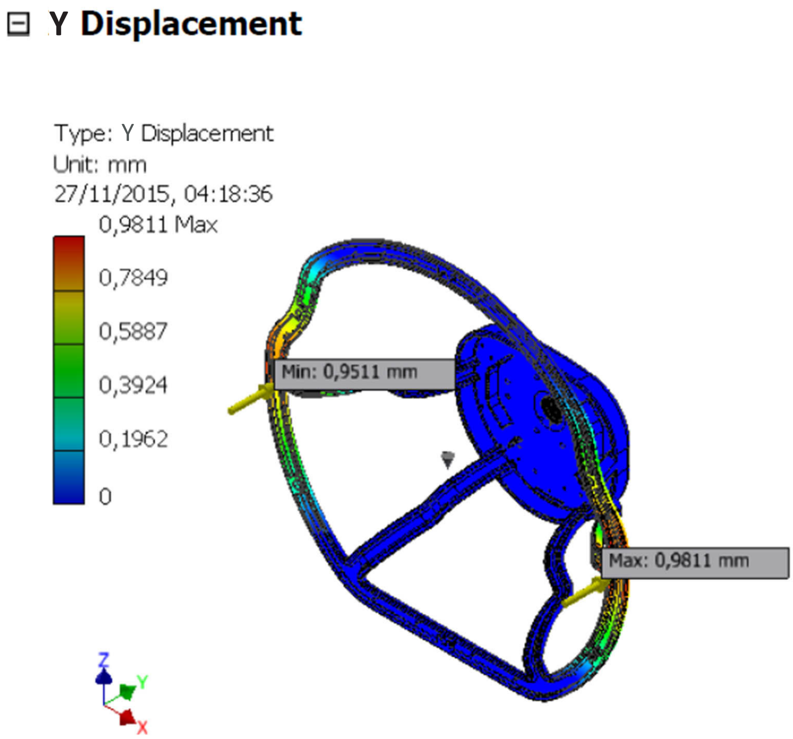
Ippocrate features a interactive screen in the center if its fron cover. This is essencially a consultive application, useful to see if somethin wrong is happening and being warned by visual outputs. It's also interactive to give the driver the possibility to customize its functions and set it up. Instead of commons capacitive screen i chose to use the resistive technology- The main problem of capacitive screens is that they're made of glass in the frontal cover. This is a main problem becaue the screen is in front of the Air Bag System so, in case of accident, it could be dangerous o have a glass screen moving in front of the driver. Resistive screens feature a plastic film screen instead of glass, this is much safer than capacitive screen option.



75. How actually Resistive screens work (the film flexibility is not scaled)

Notes

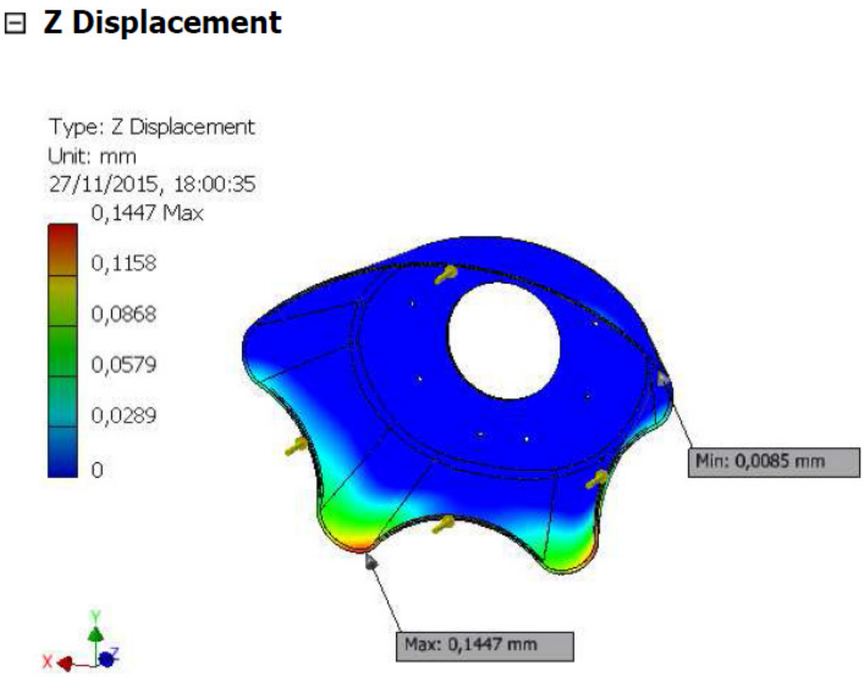
Resistive touchscreens are composed of two flexible sheets coated with a resistive material and separated by an air gap or microdots. There are two different types of metallic layers. The first type is called Matrix, in which striped electrodes on substrates such as glass or plastic face each other. The second type is called Analogue which consists of transparent electrodes without any patterning facing each other. As of 2011 analogue offered lowered production costs. When contact is made to the surface of the touchscreen, the two sheets are pressed together. On these two sheets there are horizontal and vertical lines that, when pushed together, register the precise location of the touch. Because the touchscreen senses input from contact with nearly any object (finger, stylus/pen, palm) resistive touchscreens are a type of "passive" technology.



76. Stress analysis simulation of the metal structure made with Autodesk Inventor stress analysis environment (2015)

6.7 The materials and Stress Tests

In order to prove that the structure were well-designed for their function it has been made some stress tests simulation, actually on the main structure and on the back cover. I chose to charge two forces of 500N each on the structure. That are the resulting of a deceleration from 50km/h to zero in four seconds with a weight of 40kg each. It's the simulation of a quick break while driving on the streets. It cames out that the maximum elastic deformation on the same direction axis was 0.98mm, that can be considered a pretty minor deformation. The Poisson's ration, that gives us the relationship between the strain of the material and it's deformation, was in the order of 0,002ul, when the maximum accettable Poisson's ratio for Aluminium (the chosen



77. Stress analysis simulation of the plastic back cover made with Autodesk Inventor stress analysis environment (2015)

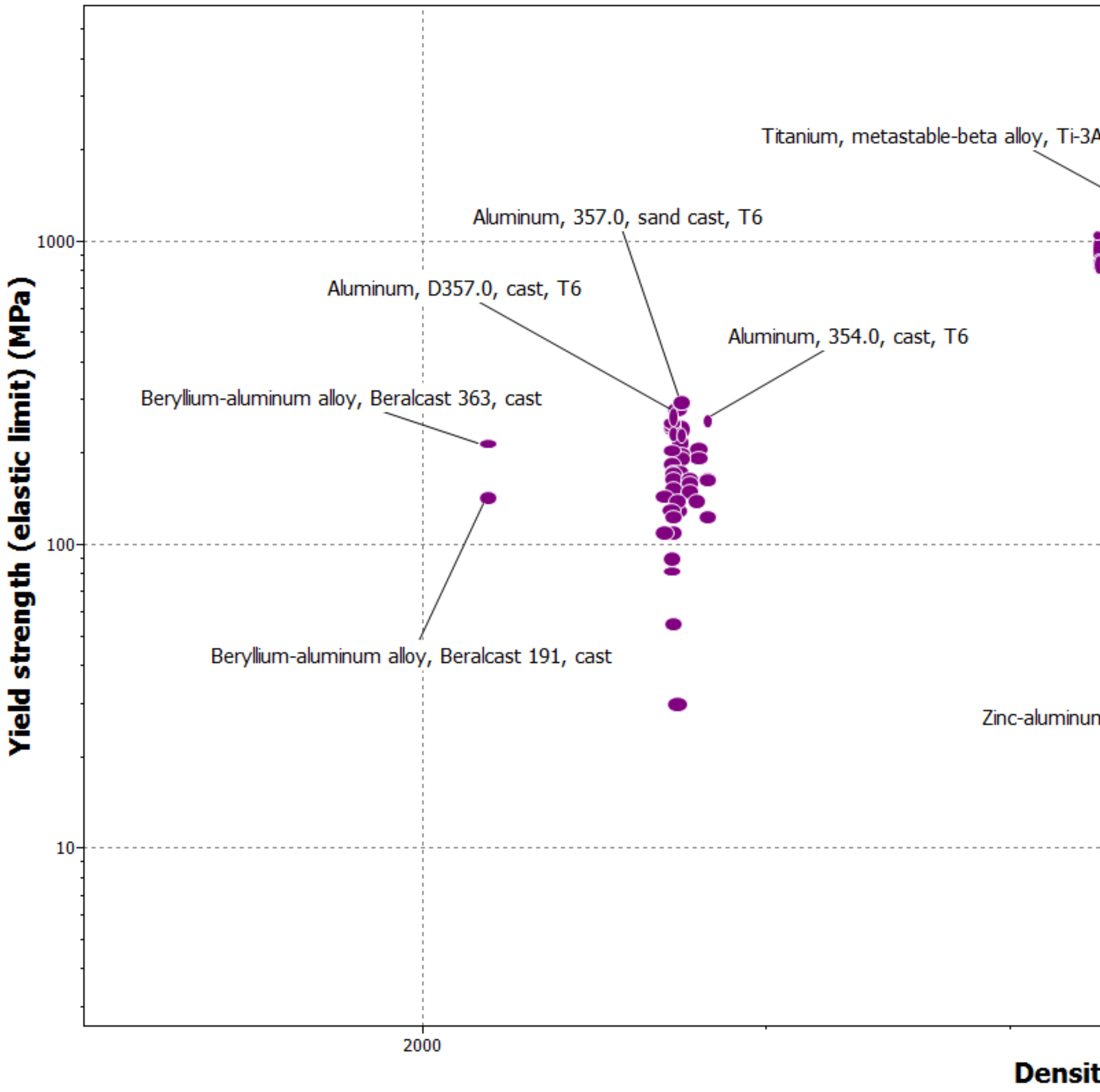
Notes

material) is approximately 0,33ul. We could safely say that the shape grant pretty well its functions and give the driver a great response in stiffness.

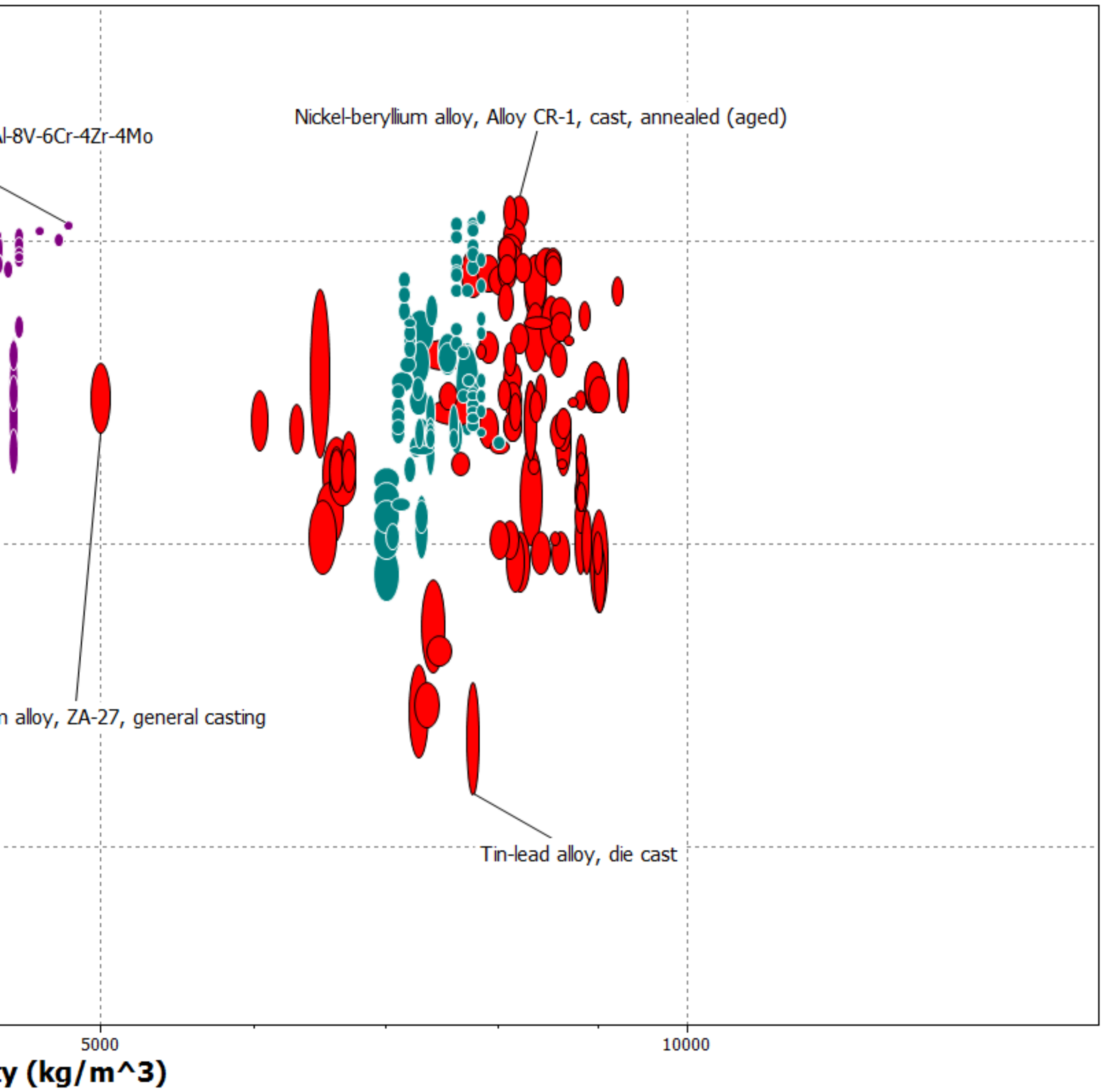
The same has been done with the back plastic cover. It's in ABS, and were loaded four forces of 100N each, to simulate human's possible force applyied on the central, plastic part. It cames out that the maximum elastic deformation on the same force direction axis was 0,14mm while the Poisson's ratio was more or less 0,01ul. The Poisson's ratio for ABS is about 0,4ul, so the calculated deformation is absolutely acceptable.

Note: the considered forces are very overloaded on this two parts to figure out if are well made or not also in impossible conditions.

78. Graph Density-Yield strength of the main metal structure made with Ces Edupack (2015)



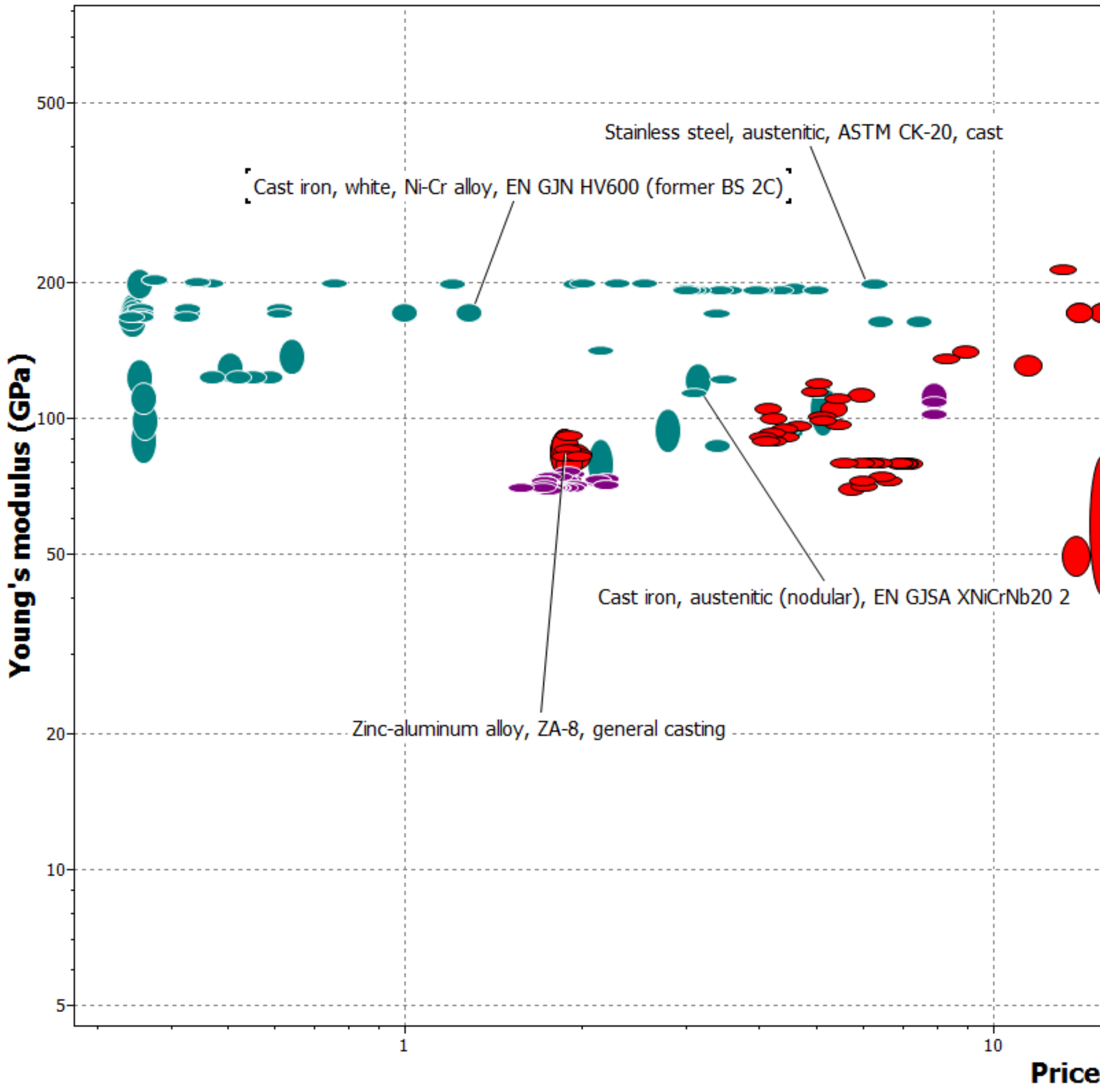
The Materials were chosen refering to those ones actually used for this kind of product and matching them with a CES analysis. It cames out that for structure low-bonded Aluminium would be the best choice to grant lightness and enough structural properties in terms of resistance and flexibility in case of impact. In particular a Zinc-Aluminium alloy could gran a perfect combination of lightness and stress-resistance. In the graph above you can see many metallic materials took into consideration and with the proper characteristic useful for this piece. On the x-axis is the density, measured in kg on cubic meters. On the y-axis it the Yield strength or elastic limit, in Giga Pascal, that can be defined as the maximum pressure until the material become deformed in a non-elastic way, and it's measured in Mega Pascal. There are many other alloy that could be take into consideration but thei density is



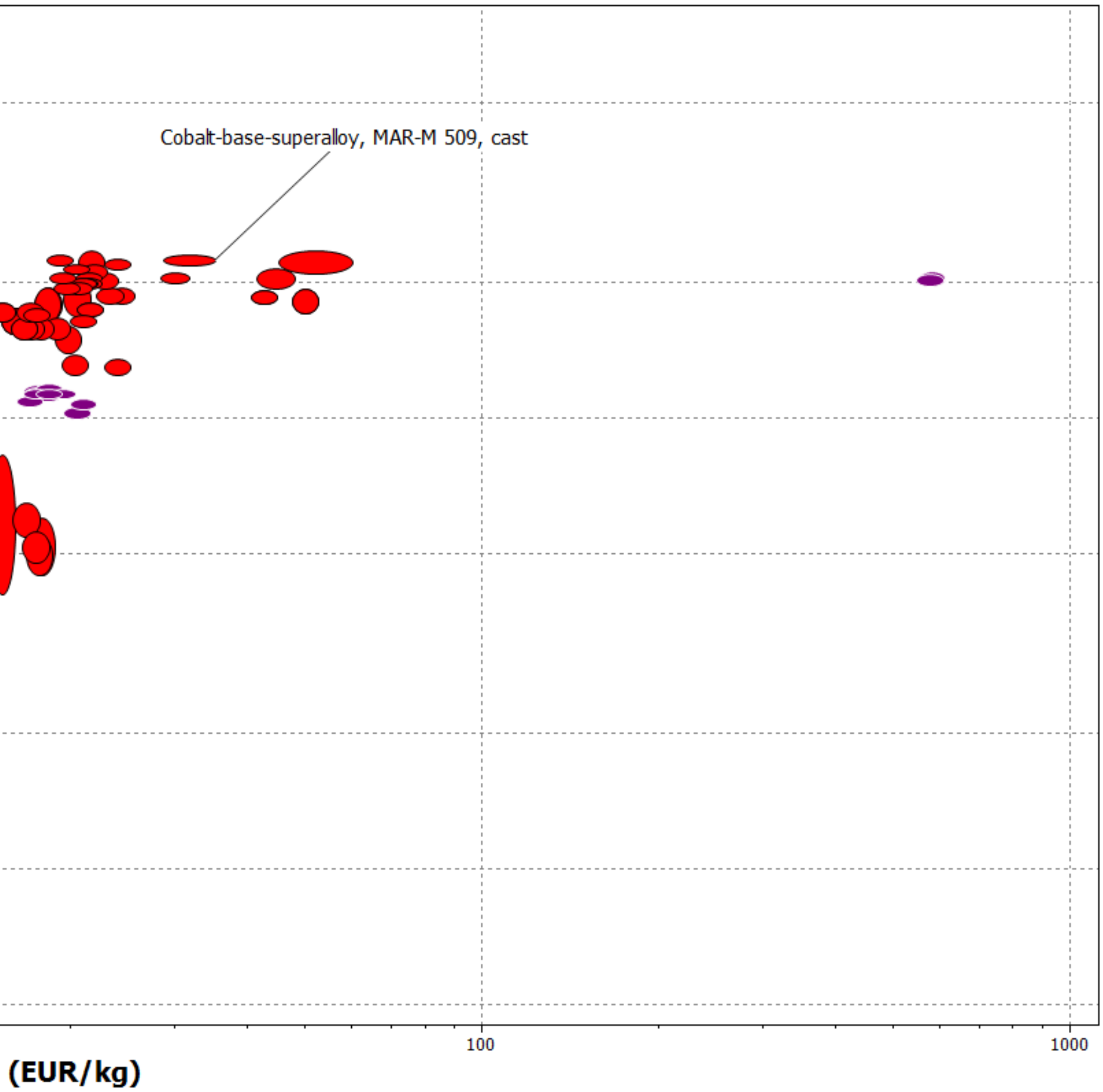
Notes

very high.
For example nickel-beryllium alloy certainly have a great behaviour in terms of mechanical properties, but they're heavy and their price, as we'll see in the nex graph, is very high. Titanium alloys have mixed properties but titanium is much more difficult to cast that Aluminium. In general were taken into cosideration all the Aluminium alloy low bounded, for example with magnesium, zinc or other non-ferrous metals. Sand casted Aluminium could be good also but in order to have a good tensile strenght i needed to make this piece in high pressure die casting molding, a process that is good also for improving the prouction timing instead of sand casting, a very slow process which responsibility is up to the workers instead of the machines. Also the precision and the finishing are lower than die casting.

79. Graph Price-Young's Modulus of the main metal structure made with Ces Edupack (2015)



This selection was made to match the previous characteristics with Price and compare the Young's modulus. This is called also elastic modulus, and it's referred to tensile deformation when applyied some forces with a deriving distortion of the shape itself. As it was told before the price of some titanium alloy is too high, and also in this case Zinc-Aluminium alloy is the best compromise between all the specifics taken into account.



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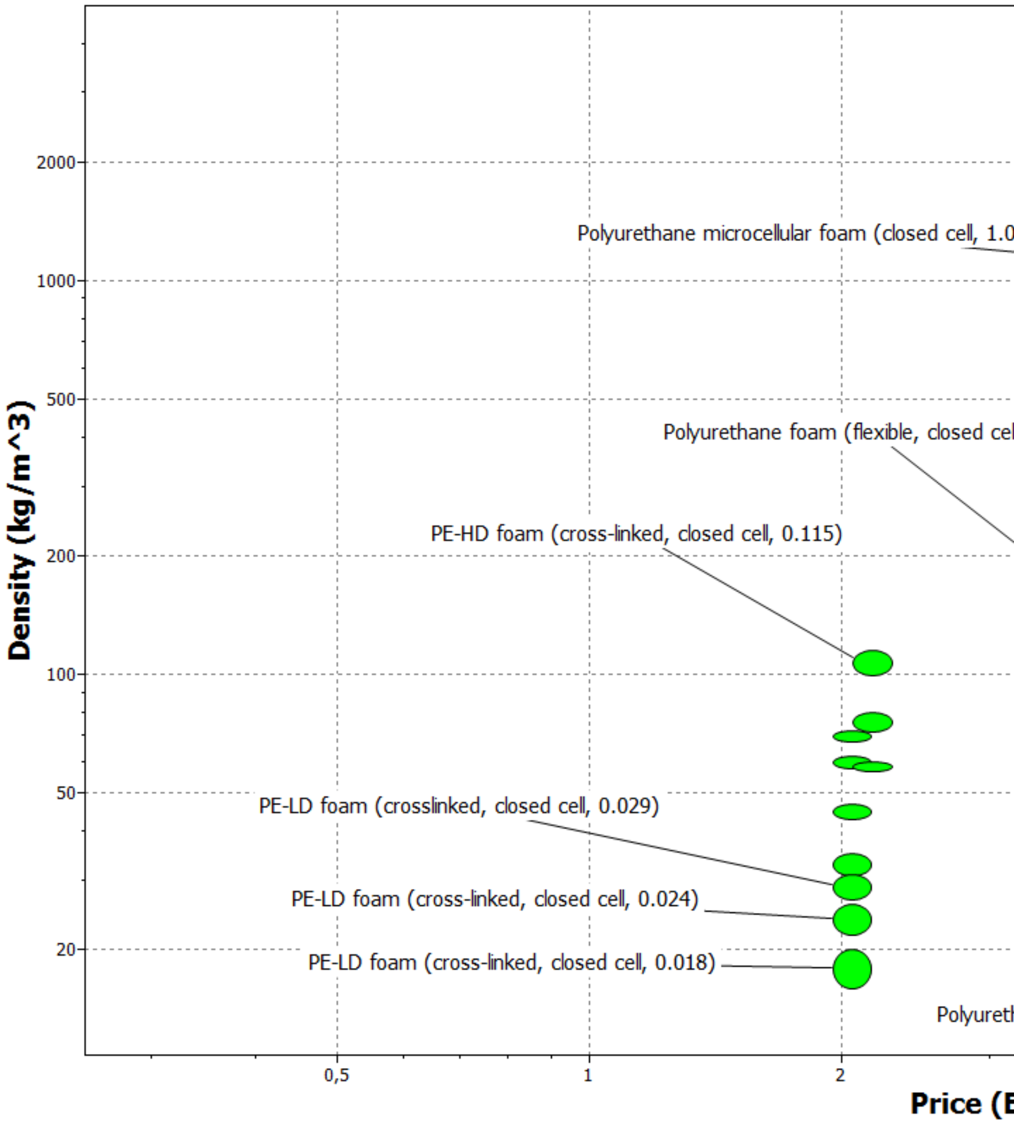
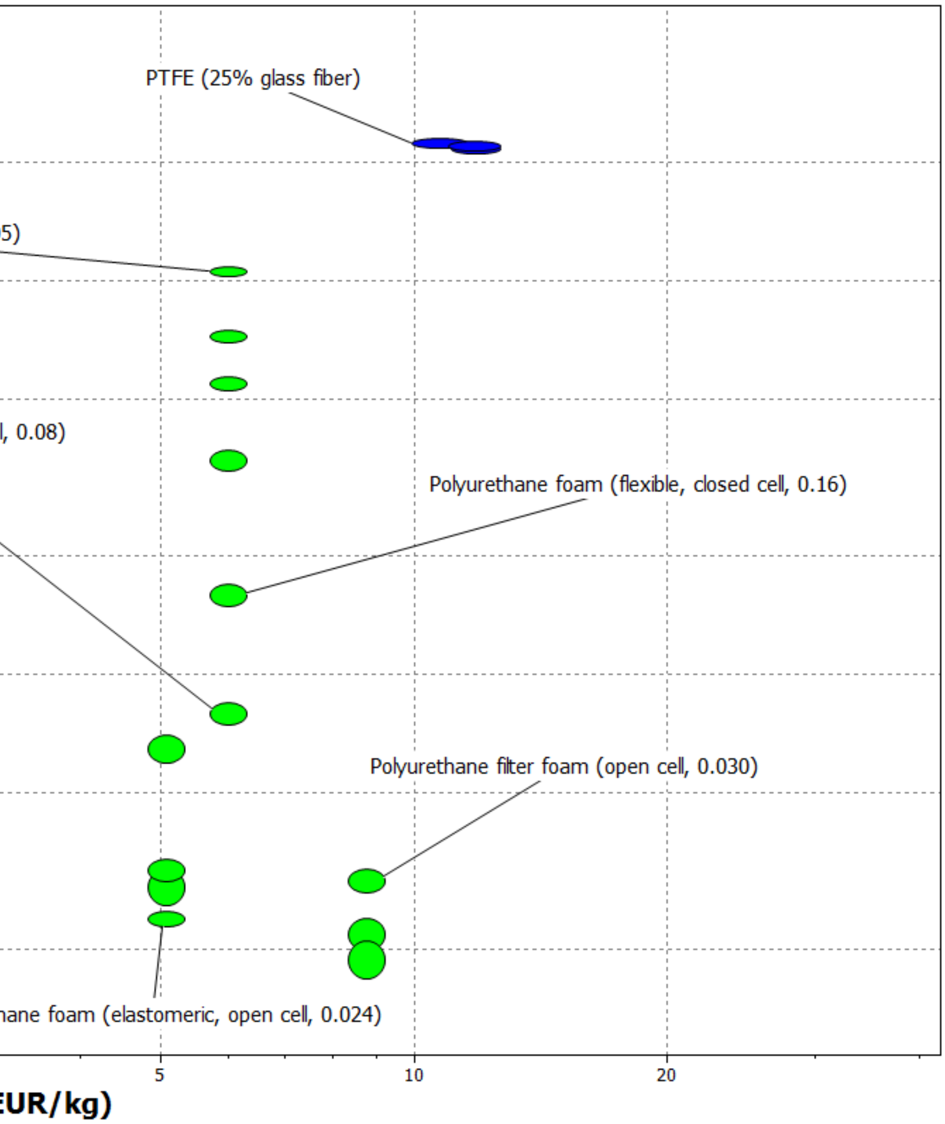
80. Graph Price-Density of the main metal structure's cover made with Ces Edupack (2015)



For the main-structure cover it were taken into account all the plastic materials. In order to have a soft touch sensation were chosen those material that, with an over reaction injection moldin above the structure could form a foam-like material, easy to grab while driving and to produce. It cames out that many materials had this property, so were considered also elongation and compression as you'll see in the next page's graphic. I chose to produce this part in Low Density Polyethilene Foam, crosslinked (about the microscopic structure), closed cells (very low electrical conductivity). It's a great material, it has a very low price, a Low Density and a perfect moldability with injection molding processes. The "Excellence" for the moldabilty in injection was one of the constraint requirements. This material respond very well to elongation stress (this was one of the requirements for the next

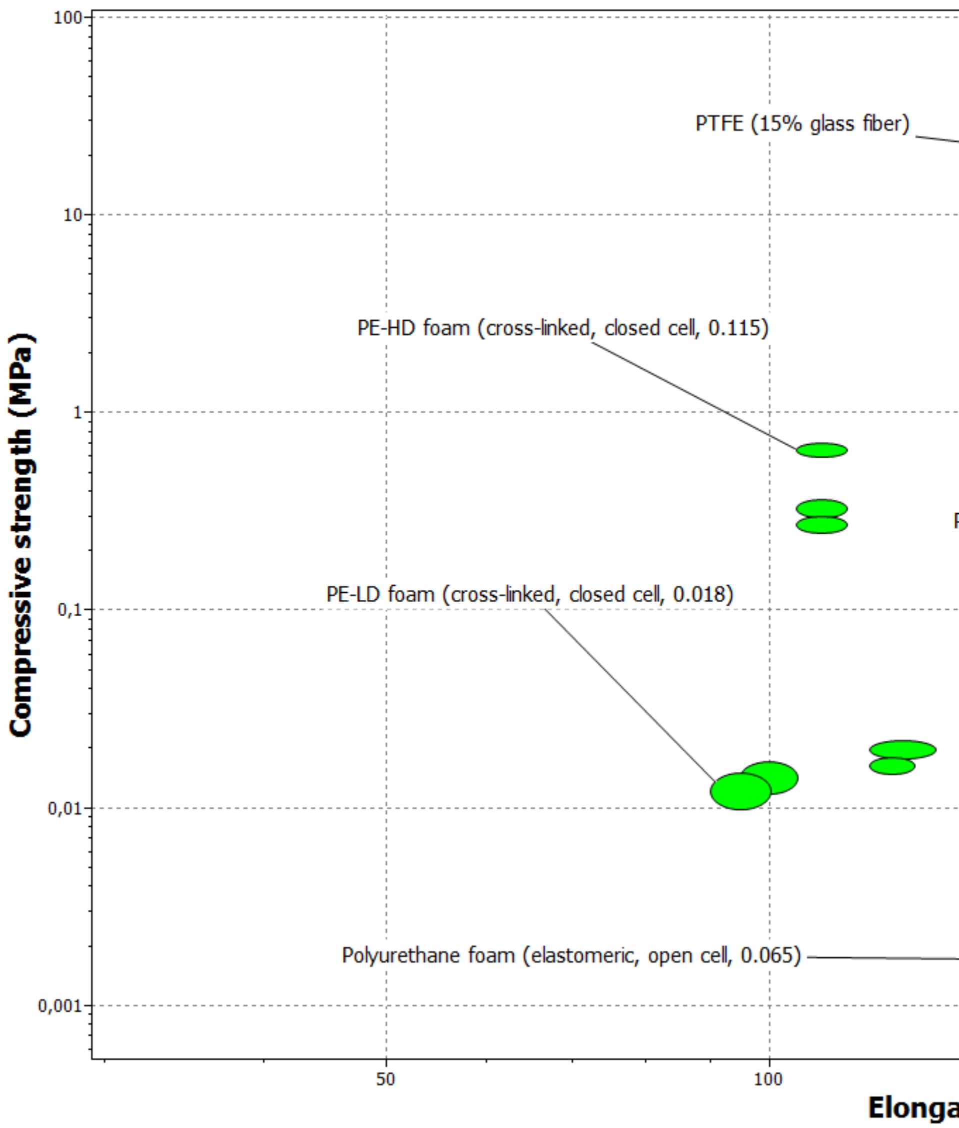


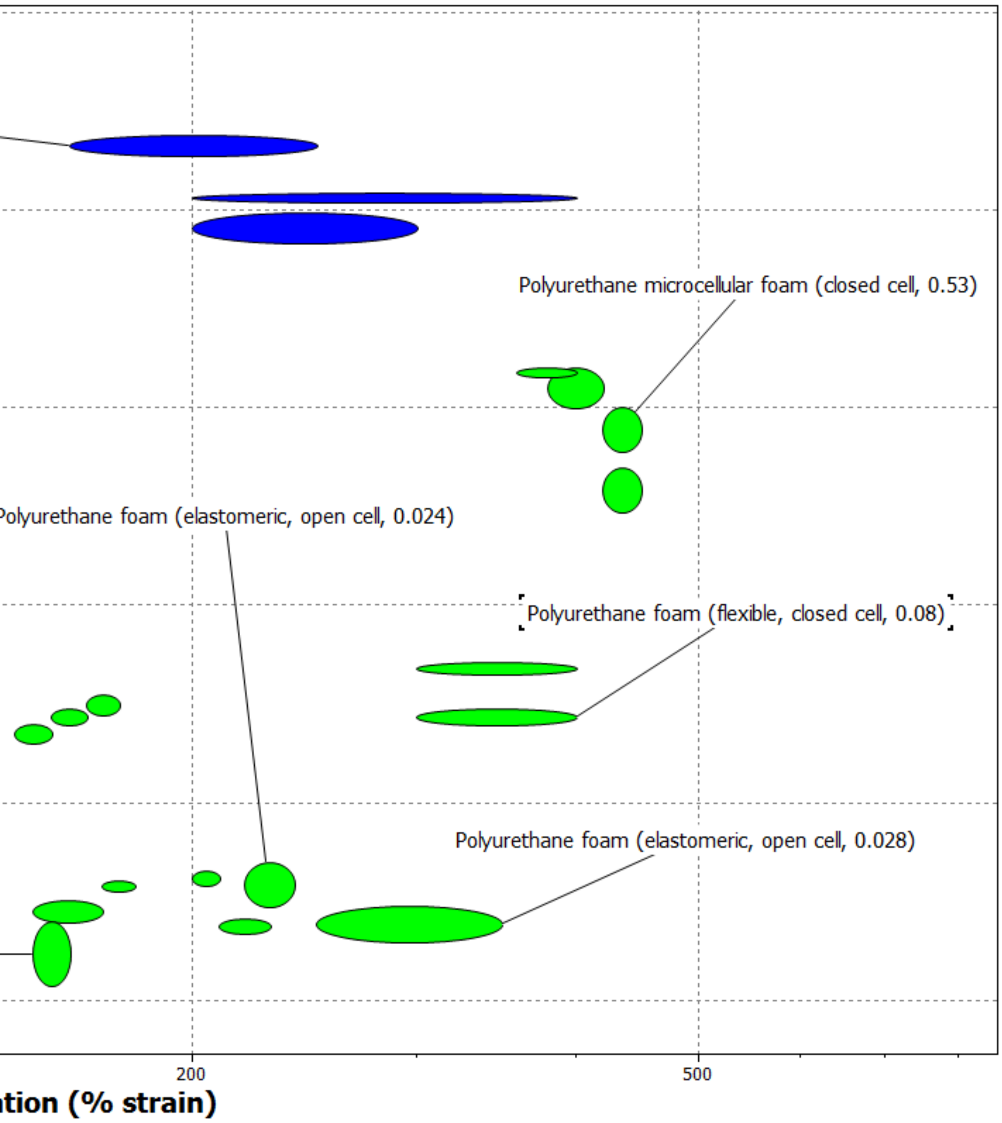
Notes

page's graph) and it's soft enough to give the driver a good feeling and a safe grab on the steering wheel's ring.

For the other parts i chose to make the main covers in ABS plastic, with a good touch feeling and greast moldability in injection, mechanical property acceptable and very good paintability. Inside the steerign wheel are some sheet metal parts made in industrial Stainless Steel, their requirements are not primary because are just guides, well-closed into the steering wheel.

81. Graph Elongation - Compressive Strenght of the main metal structure's cover made with Ces Edupack (2015)




Polyurethane microcellular foam (closed cell, 0.53)
Polyurethane foam (elastomeric, open cell, 0.024)
Polyurethane foam (flexible, closed cell, 0.08)
Polyurethane foam (elastomeric, open cell, 0.028)
200
500
tion (% strain)

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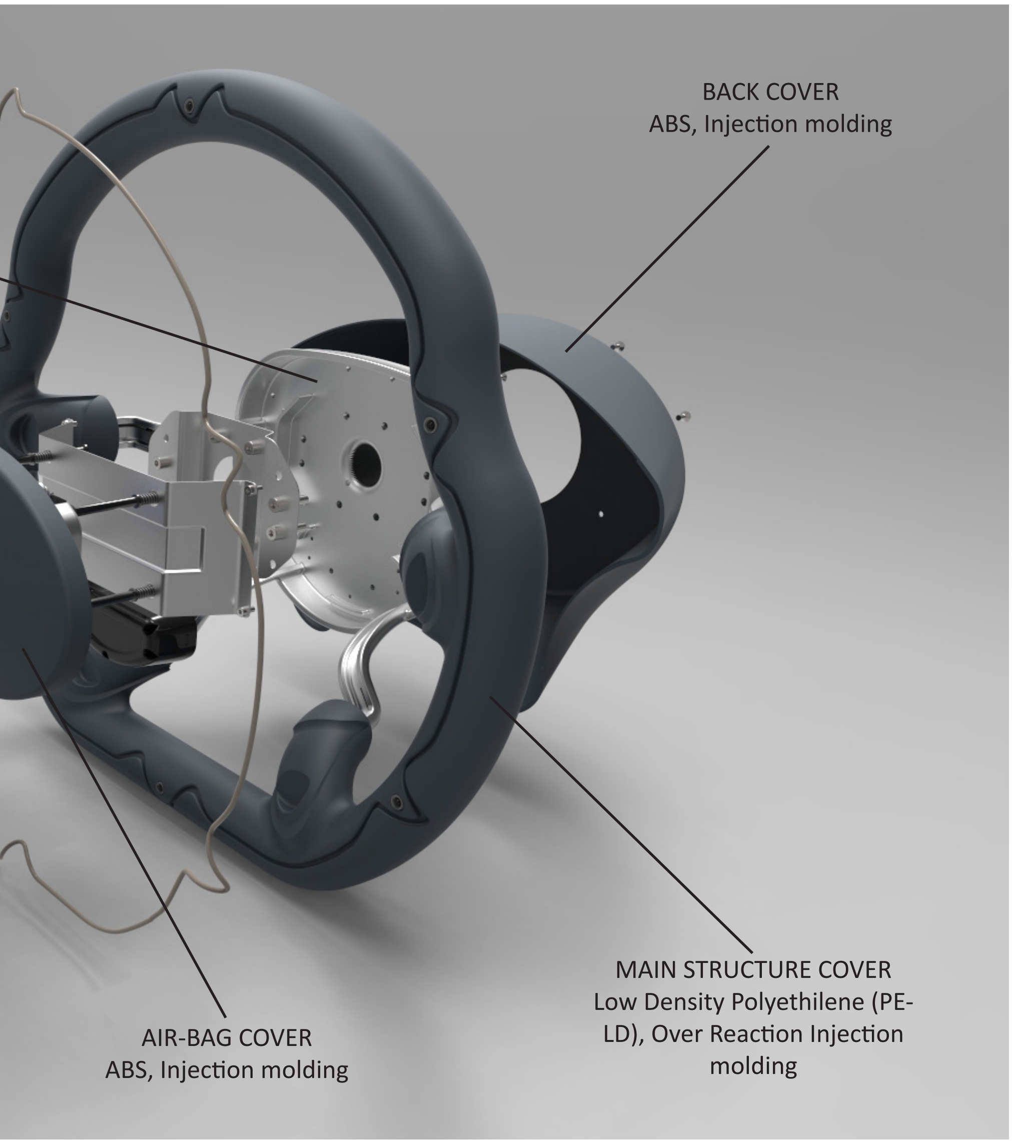
82. Ippocrate Exploded View with material's details (2015)


BACK COVER
ABS, Injection molding
MAIN STRUCTURE COVER
Low Density Polyethilene (PE-LD), Over Reaction Injection molding
AIR-BAG COVER
ABS, Injection molding

Notes

83. Ippocrate's raw rendering simulation from front - bottom - left (2015)

84. Ippocrate's raw rendering simulation from front - top - right (2015)

85. Ippocrate's raw rendering simulation from front - centre - right (2015)

86. Ippocrate's raw rendering simulation from back - centre - right (2015)

87. Ippocrate's raw rendering simulation from front - top - left (2015)

Notes

88. Ippocrate's raw rendering simulation from front - centre (2015)

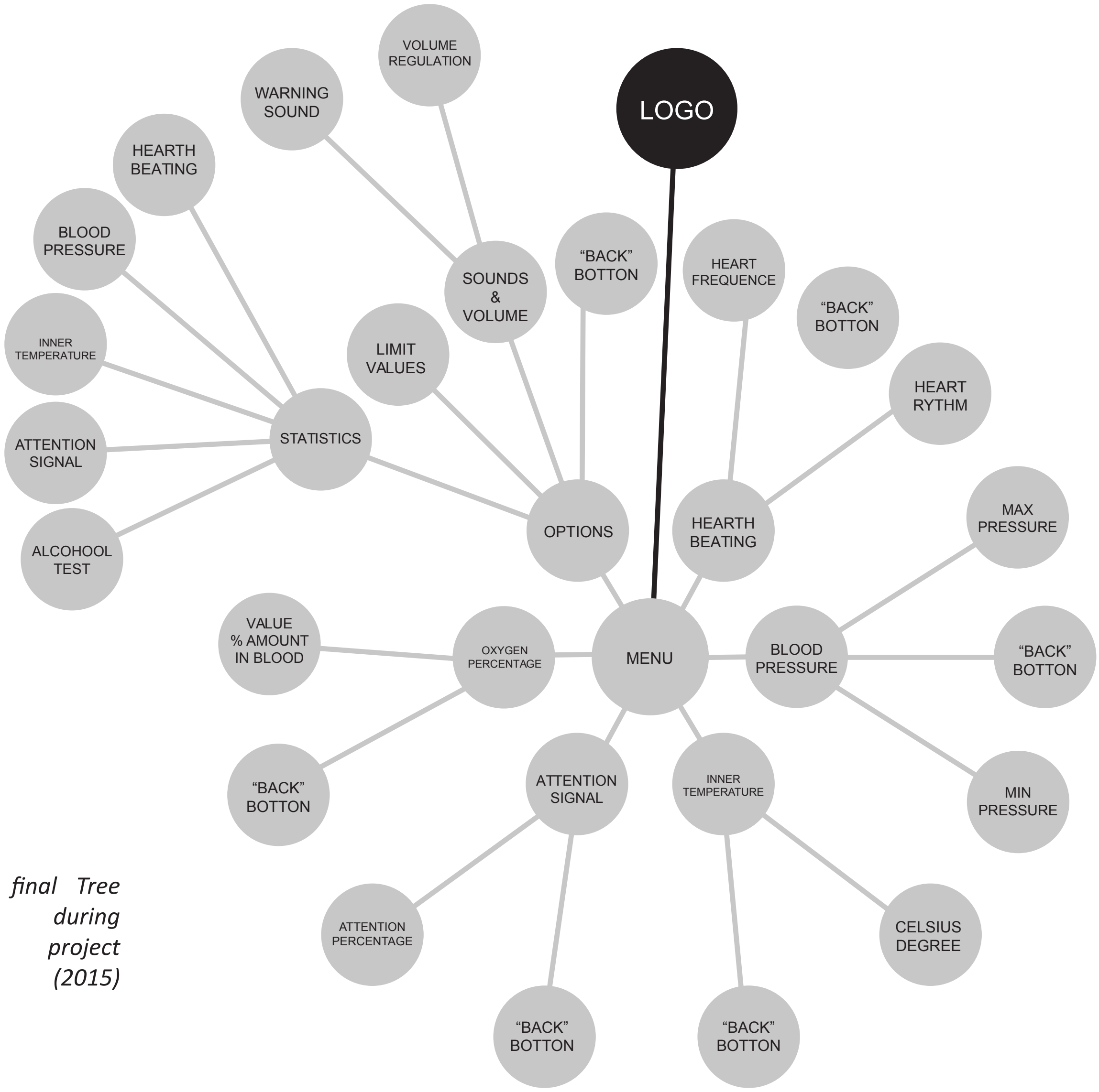
89. A rendering example of just Ippocrate's screen with the "home" manu while working (2015)

7. The App

This last chapter is about the application or App, right in the central screen of Ippocrate. The App could be described as an informative App, something you can consult when you're standing still with your car. It's also something designed to warn if something is going Wrong with your physical status. The intention was to make a mockup of the App without make redundancy and limiting the features not to distract the driver while he's focused of the street. For this reason its design is very minimal, made just of few icons, avoiding effects and everything could be dangerous for your attention. This App works with color advertisement so have been taken the colors from the traffic lights and used on the icons to make them visible and intuitive. This is

a main point of this app. As stated before, to make something very new and never done before, it's important that it's very intuitive, easy to understand with no explanation. All the design and icons are invented by the author of this thesis thinking about the user's experience and its attitude to information's translation.

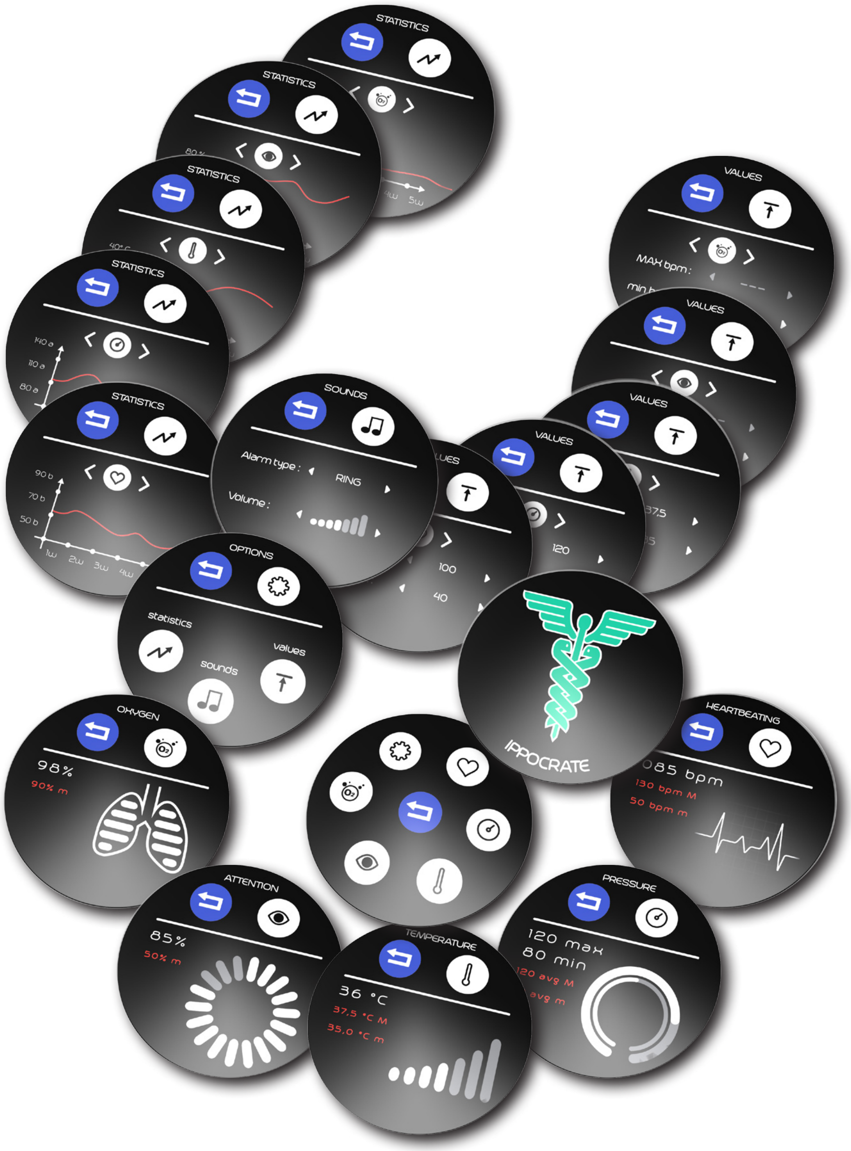
Note: This App was developed during the Erasmus Experience in Aachen (Germany) from March to July 2015 with the help of Professor Wolfgang Gauss in the course named "Interaction Design".



90. The final Tree made during erasmus project (2015)

7.1 Tree's organization

Before creating the App itself it was made the organization tree. This tools is very useful for the designer to make an App that is well divided in all its functions to make the users not waste their time while using this tool. As you can see in the image above about the tree, After the Logo you go inside the sub-menu, this area it's the main one and stays on during the driving, Warning you with colors if some parameters are out of the limit values. This Menu is inspired from old-phone organization numbers, all in a circle and round shaped. In the centre there's the "back" button to go back to the Logo, turning-off the App. After the main Menu you can go into the single menu for the parameters and into the options menu. In all the singular parameter's



91. Some rendering example of the Ippocrate's App sub-menus (2015)

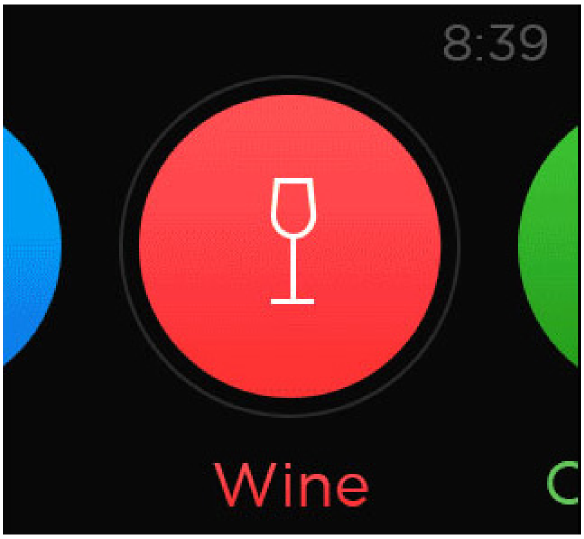
Notes

menu you can see the fluctuationd of data in live, how that is varying and the numeric values. Visually these values are represented with Icon, all placed in the same position, made to let the driver instinctively know what's happening. The datas themselves are placed in the same position, in white the actual data value, in red the top or bottom limit when there's one. Also these sub-menu have a back-button in order to return to the main menu. The graphic choices are made to make these feature very recognizable, easy to understand, all different from each other in terms of visual impact and shape, to make them not creating misunderstanding during the consultation. In the Option menu you can find sound regulation, limit values settings and the statistics of the past days of monitoration.

92-93-94. Some ex. of the round-shape graphics for digital clock, statistics and music navigation

7.2 Style

The style for Ippocrate's App was made taking into account the semplification of the shapes, their immediate recognition and in general a minimization of all the features not to distract the users. As you can see in the images above and the next pages everything is based on the circle. This choice was made because of the shape of the screen and due to the style of the steering wheel itself, very roundy and with a strong smooth style. The icons are very minima, made just of lines. They are also flat, with no shadows or gradient effects,

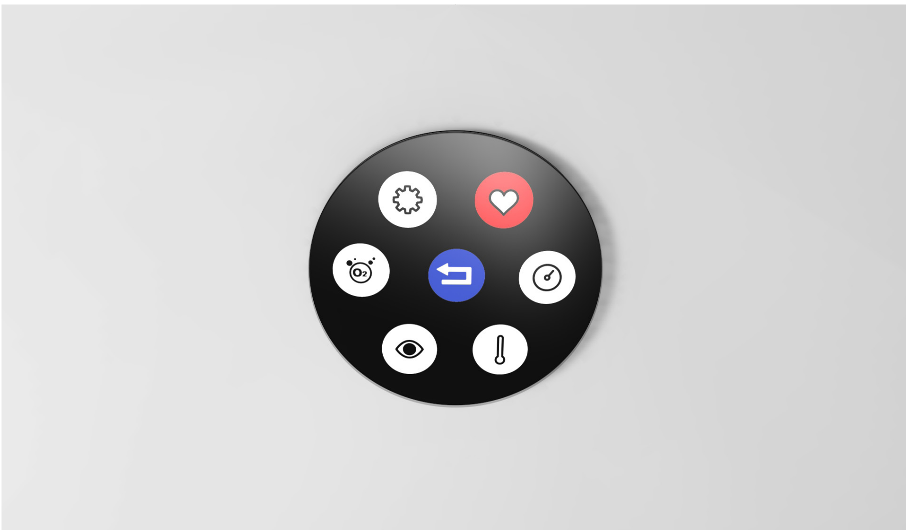


95-96-97. Some ex. for an App about events, an App about daily organization and one about work's organization

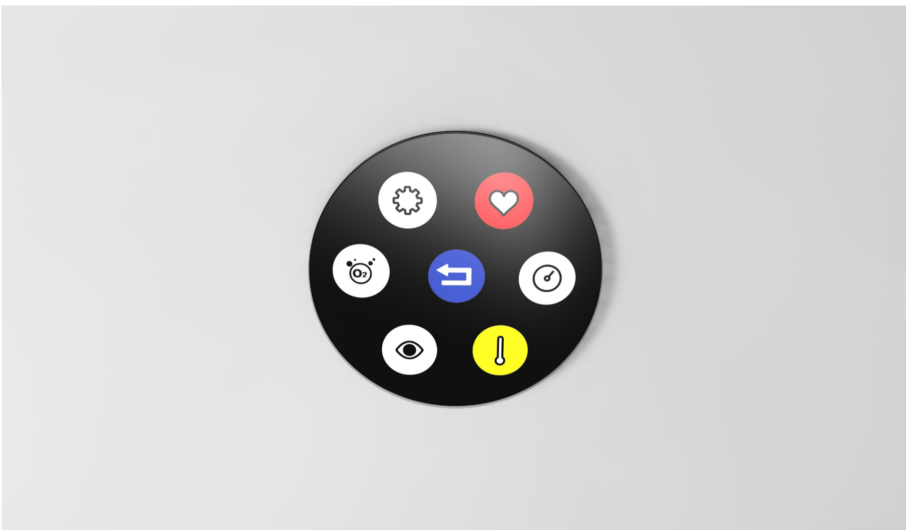
Notes

with no background or fluctuating images. These choices let this App to be very easy to consult, immediately readable and customizable with few clicks. The color selection is also very simple: black for the background, white for lines, pure yellow for a weak advertisement and pure red for a stron one. Of course these colors are already associated to danger or advertisement, i just took them not to change the perception habits of the users. I also took insipiration from the old-phone with the circular dial and smaller circles for number's selection. That object is cultural archetypical and it's easy for the user to associate functions and actions.

98. *Main Ippocrate's menu with all the parameters inside the limit values (2015)*



99. *Main Ippocrate's menu with one parameter very out of the limit values (2015)*

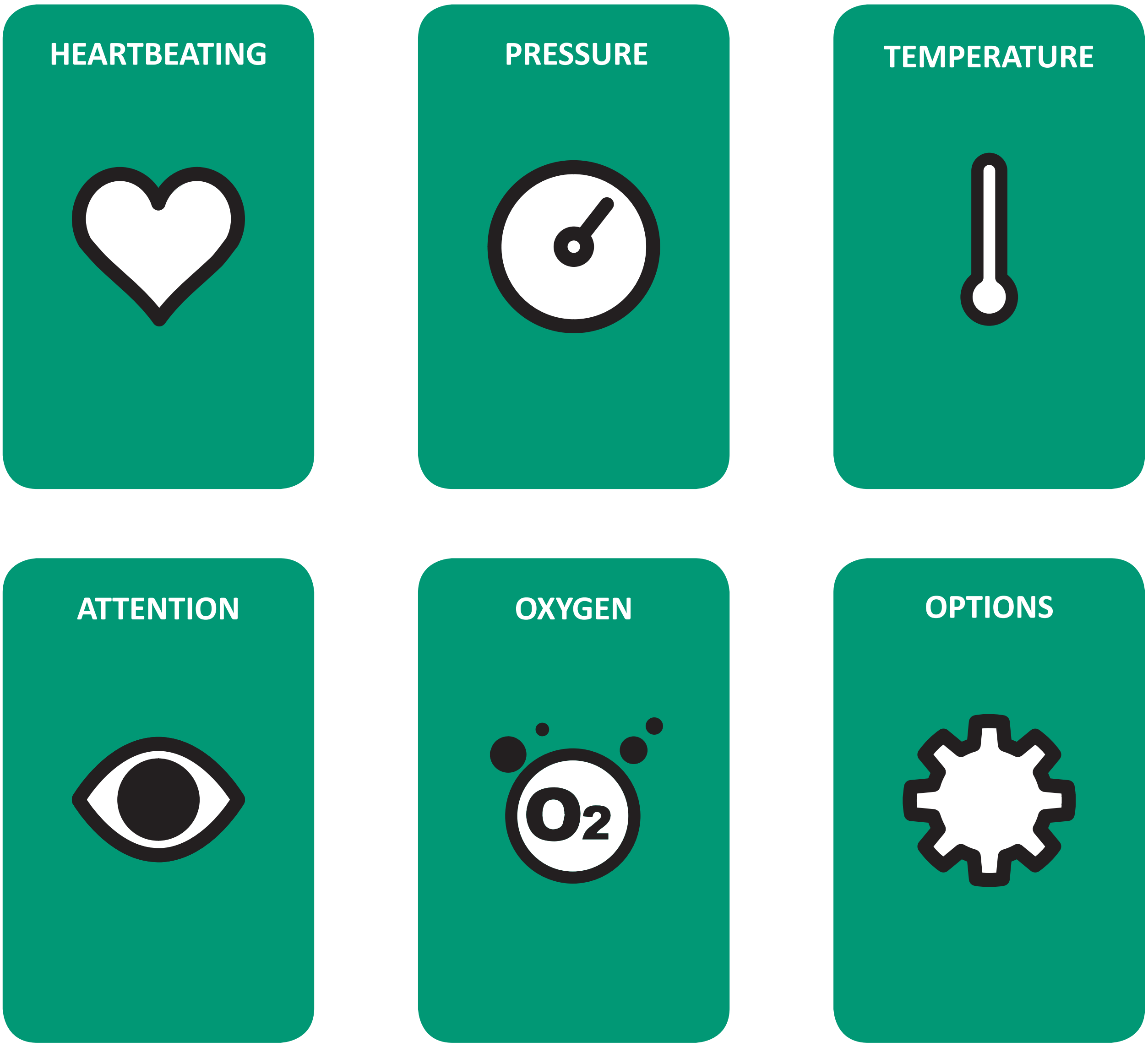


100. *Main Ippocrate's menu with one parameter very out of the limit values and one other slightly out of them (2015)*

101. Datas Ippocrate's menu with the selected parameter inside the limit values (2015)

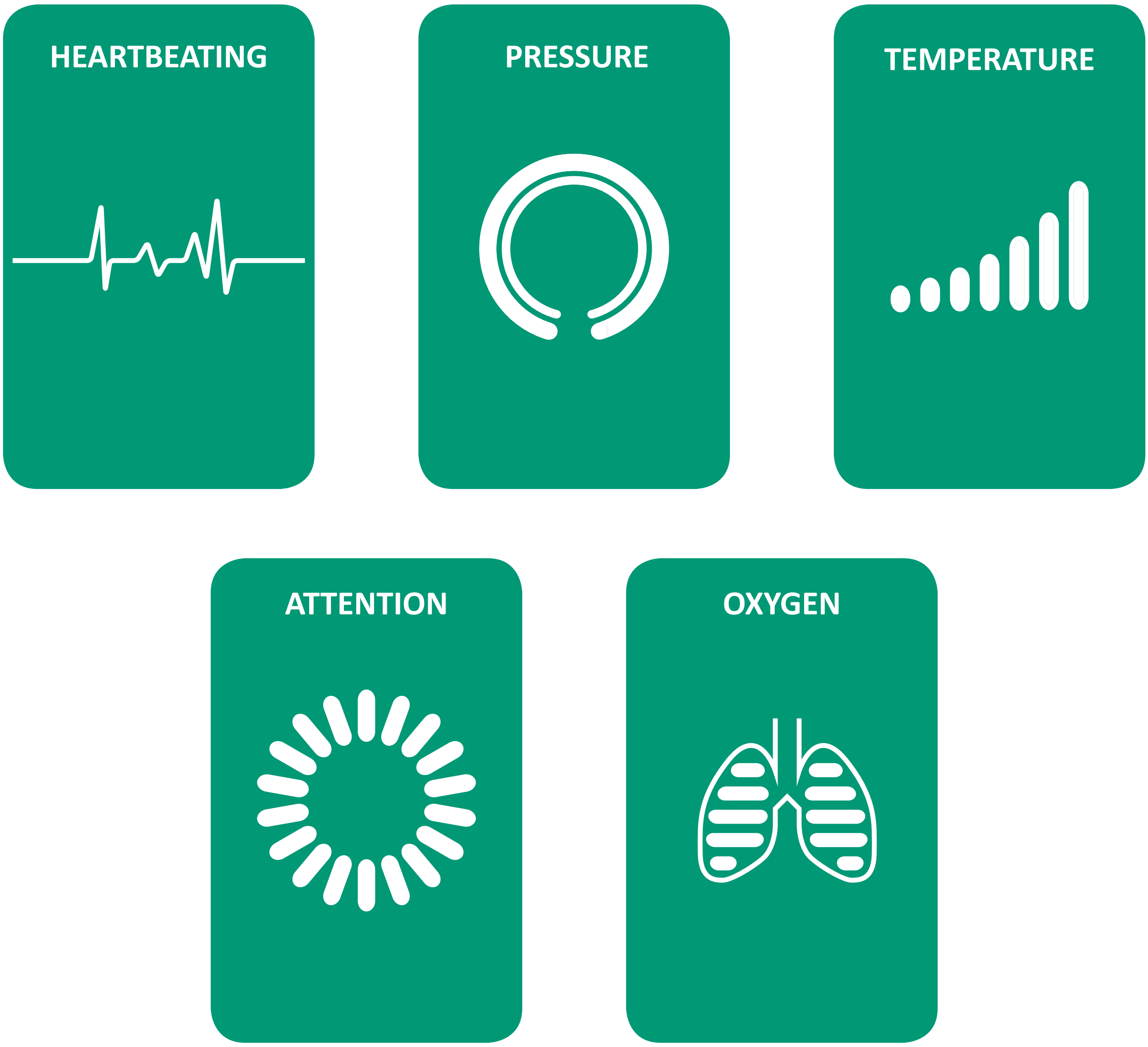
102. Datas Ippocrate's menu with the selected parameter slightly out of the limit values (2015)

103. Datas Ippocrate's menu with the selected parameter very out of the limit values (2015)



7.3 Icons and colors

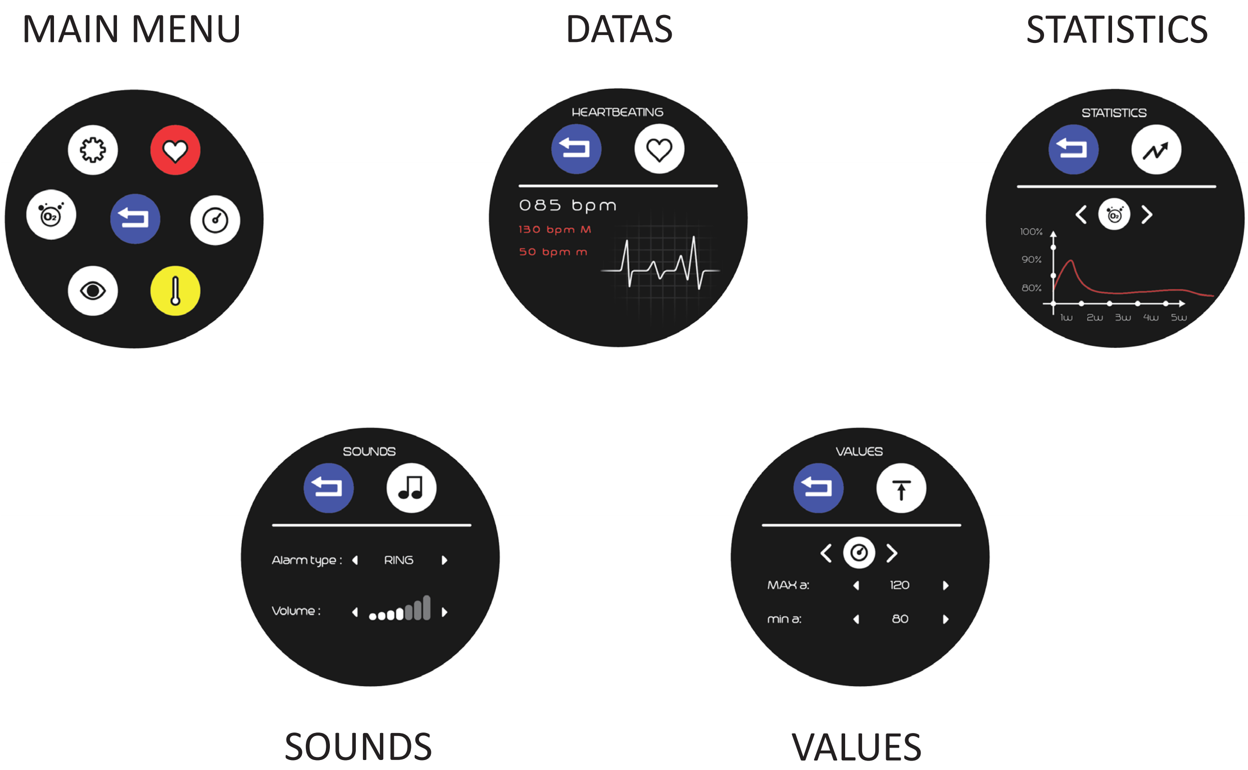
You can see in the images above icons and graphics. On the left are the icons, from left to right: Heartbeating, Pressure, Temperature, Attention, Oxygen and Options. The Heartbeating of course is base on a simpe heart, the pressure is ispired by a manometer, the temperature icon is based on a termometer, the attention that measure the view-direction with eye tracking is indeed an eye, the oxygen level is a stylized molecule of oxygen, the options button is



Notes

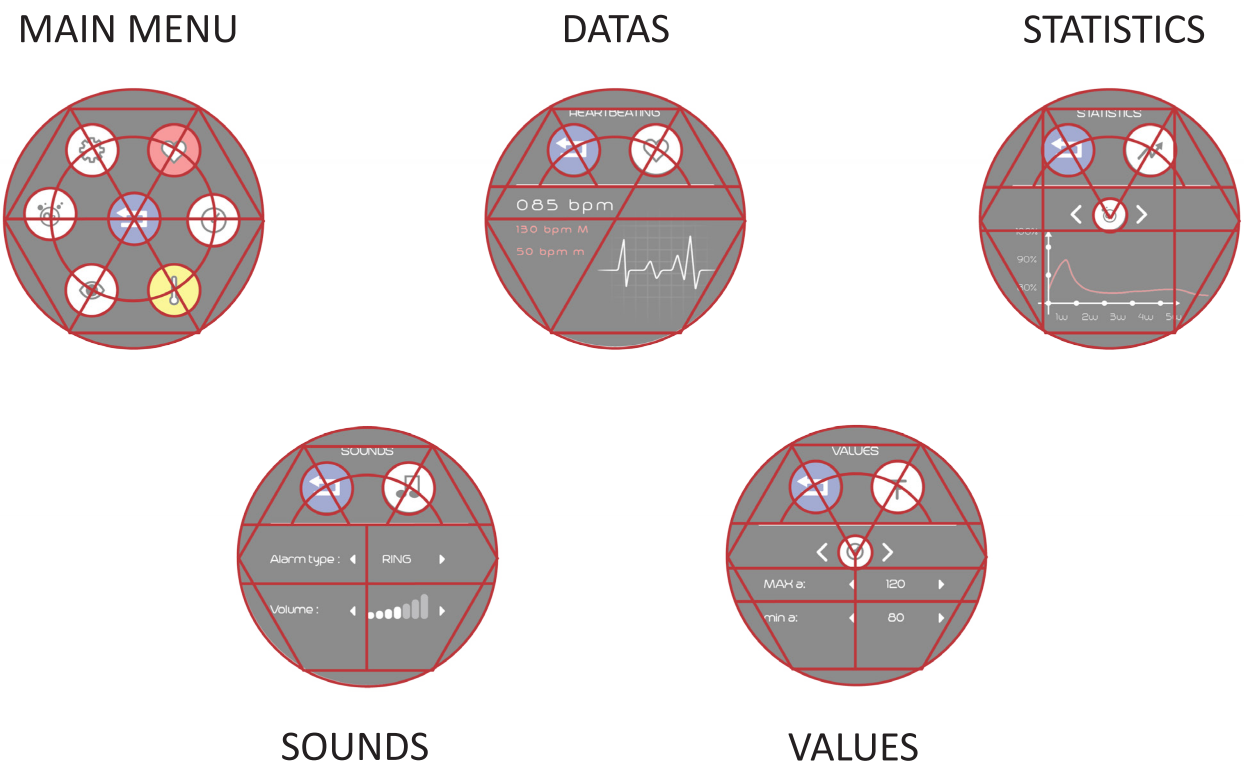
a gear as used in most of the apps nowdays. For the graphic i chose not to make the to much stylish if possible: for the heartbeating is the echocardiogram line, for pressure is a smoothed and circular line, for temperature some increasing levels, for attention a circular pattern and for oxygen are two limbs filling with marking lines according to the oxygen level. The icons are a little more minimal than the graphics, this is due to the fact that you can see the icons while driving and they have to be not to muck attention-catcher. On the other side you will see the graphics in detailed datas maybe when you're standing still, so they have more detail.

104. The five different screens for Ippocrate's sub-menus (2015)



7.4 Wireframe

At last a briefly description about the wireframe organization of the screen. Basically there are five different screen wireframe made in base of the context. All the screens are organized following an exagonal content filling, divided in diagonals sections where took place the icons or the graphics contents. The orizontal sections are made for the texts informations. Above the lines of division (in Red) take place the lines of the app (in white), the regulation arrows or the changing menu buttons. Very important is the back-button, *105. The five different wireframes for Ippocrate's sub-menus (2015)*



Notes

in blue, that take place in the main menu in the centre, in the sub-menues on top-left, everytime in the same position to simplify the driver the navigation.

Please remind that this App is a tool for a particular objects, made for this specific application, with a design that fit onto it from the very first intentions.

8. Storyboard Examples

You will find now some rendering made for make the reader completely comprehend the usability of Ippocrate, the way it will be use, the wy it should be used, the interactions between the driver and the tool. The following are just some examples of the driver's behaviour, mostly using his hands to direction the car and use tha App inside the steering wheel.


MENU


OK


25°c
FM
12:15
22.5
22.5
AUTO
A/C
MENU
D


OK


25°c
FM
12:15
22.5
22.5
AUTO
A/C
MENU


OK


25°c
FM
12:15
22.5
AUTO
22.5
A/C
MENU

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Textual Quotes

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[13] Findomestic statistics from “L'Osservatorio” (2015), Page 27

[14] Findomestic statistics from “L'Osservatorio” (2015), Page 31

[15] Findomestic statistics from “L'Osservatorio” (2015), Page 33

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[41] Statistics taken from “Insurance institute for Highway Safety”
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Images

(Img1) www.obikol.com/photos_product/free_photos/Steering%20Wheel%20Vintage%20Ford.jpg
(Img2) www.barchedepocaeclassiche.it/images/bec13/La-goletta-Pandora-navigare/La20barra20di20Pandora_20Foto20Maccione.JPG
(Img3) www.daimler.co.uk/Images/History/daimler_1.jpg
(Img4) www.2.bp.blogspot.com/-WswaLooaZCM/Ux4_GfG6FHI/AAAAAAAAHVs/B-Uph063f0I/s1600/74882592114-29.jpg
(Img5)upload.wikimedia.org/wikipedia/commons/b/bc/Ford_Mustang_Bj_1964_100_PS_6_Zylinder_3,3_l_Hubraum_Armaturen.jpg
(Img6) wheelrush.com/wp-content/uploads/2015/09/1974-Ford-Mustang-Steering-Wheel-1024x683.jpg
(Img7) wheelrush.com/wp-content/uploads/2015/09/1979-Ford-Mustang-Steering-Wheel-1024x683.jpg
(Img8) wheelrush.com/wp-content/uploads/2015/09/1984-Ford-

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(Img9) wheelrush.com/wp-content/uploads/2015/09/1990-Ford-Mustang-Steering-Wheel-1024x683.jpg
(Img10) wheelrush.com/wp-content/uploads/2015/09/1994-Ford-Mustang-Steering-Wheel-1024x683.jpg
(Img11) preview.netcarshow.com/Ford-Mustang_GT-2005-1280-50.jpg
(Img12) wheelrush.com/wp-content/uploads/2015/09/2013-Shelby-GT500-Steering-Wheel-1024x683.jpg
(Img13) wheelrush.com/wp-content/uploads/2015/09/2015-Mustang-Steering-Wheel-1024x683.jpg
(Img14) wheelrush.com/wp-content/uploads/2015/09/2015-Shelby-GT350R-Steering-Wheel-1024x683.jpg
(Img15) www.hqpictures.net/wp-content/uploads/2015/09/Formula-1-Mercedes-Benz-Steering-Wheel-1280x800.jpg
(Img16) www.wtf1.co.uk/wp-content/uploads/2014/03/BjyAL7jIYAAXMho.jpg
(Img17)www.cdn2.bigcommerce.com/server2400/hnkp4dn/product_images/uploaded_images/hyundai-veloster-rally-car-interior-dashboard-9.jpg
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(Img20)www.standbyformindcontrol.com/wp-content/uploads/2015/05/Mad-Max-Inspired-Artists-Back-Cover-Image.jpg
(Img21) www.cdn.carwitter.com/wp-content/uploads/2013/12/2013-Citroen-C4-Picasso-Review-Steering-Wheel-carwitter.jpg
(Img22) www.rjmobilityservice.com/wp-content/uploads/2011/06/mps-spinner-knob_3.jpg
(Img23) www.jmobilityservice.com/wp-content/uploads/2011/06/mps-quad-fork-pinner_3.jpg
(Img24) www.rjmobilityservice.com/wp-content/uploads/2011/06/

mps-tri-pin-spinner_3.jpg
(Img25) www.rjmobilityservice.com/wp-content/uploads/2011/06/mps-palm-spinner_3.jpg
(Img26) www.rjmobilityservice.com/wp-content/uploads/2011/06/mps-amputee-spinner_3.jpg
(Img27) www.rjmobilityservice.com/wp-content/uploads/2011/06/mps-single-post-spinner_3.jpg
(Img28) www.i.ytimg.com/vi/p4u0Z4OxMDY/maxresdefault.jpg
(Img29) L'Osservatorio Findomestic (2015), Page 03, Graphic
(Img30) L'Osservatorio Findomestic (2015), Page 25, Graphic
(Img31) L'Osservatorio Findomestic (2015), Page 27, Graphic
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jpg
(Img44) www.jeffbots.com/maria-large.jpg
(Img45)Diagram of driver’s perception and decision-making process
(Moore, 1969)
(Img46) A preliminary sketch of Ippocrate (2015)
(Img47) A scheme about the designing process made for Ippocrate in
the first time
(Img48) A raw modelrendering of Ippocrate (2015)
(Img49) http://d3qpq7e7yxjovl.cloudfront.net/content/
ajpadvan/38/2/109/F4.large.jpg
(Img50)http://history.amedd.army.mil/ancwebsite/uniformpres_files/
images/insignia/Emblem.jpg
(Img51) The Wireframe Structure of Ippocrate's Logo (2015)
(Img52) The first attempt to design Ippocrate (2015)
(Img53) The final Ippocrate project well-grabbed with resting wrists
(2015)
(Img54) First Ippocrate with comfort issues like standard steering
wheel (2015)
(Img55) A section of the outer ring to show the elliptical shape of the
part (2015)
(Img56) The assembly between the aluminium structure and the
Polyisocyanate cover molded on it (2015)
(Img57) The line carved on the outer part of the wheel (2015)
(Img58) Exploded view of the central parts (2015)
(Img59) Particular of the internal parts (2015)
(Img60) The three main parts of the central assembly (2015)
(Img61) A particular view of the inside parts (2015)
(Img62) The assembled on-wheel commands (2015)
(Img63) The exploded on-wheel commands (2015)
(Img64) Sensors' areas made on evidence on the steering wheel
(Img65) Some driving position of your hands while driving with

Ippocrate
(Img66) A scheme of how photo pethysmography works
(Img67) Optical sensor
(Img68) http://www.mdpi.com/sensors/sensors-15-25507/article_deploy/html/images/sensors-15-25507-g001.png
(Img69) The two detection cameras mounted on the frontal cover of Ippocrate
(Img70) The two detection camera as seen from the front
(Img71) Some photos about a corneal reflection test. In white circled red is highlighted the reflection
(Img72) http://usabilitygeek.com/wp-content/uploads/2014/08/what-is-eye-tracking-infra-red.jpg
(Img73) The location of the screen seen from the front
(Img74) An exemple of a user-screen interaction
(Img75) How actually Resistive screens work (the film flexibility is not scaled)
(Img76) Stress analysis simulation of the metal structure made with Autodesk Inventor stress analysis environment (2015)
(Img77) Stress analysis simulation of the plastic back cover made with Autodesk Inventor stress analysis environment (2015)
(Img78) Graph Density-Yield strength of the main metal structure made with Ces Edupack (2015)
(Img79) Graph Price-Young's Modulus of the main metal structure made with Ces Edupack (2015)
(img80) Graph Price-Density of the main metal structure's cover made with Ces Edupack (2015)
(Img81) Graph Elongation - Compressive Strenght of the main metal structure's cover made with Ces Edupack (2015)
(Img82) Ippocrate Exploded View with material's details (2015)
(Img83) Ippocrate's raw rendering simulation from front - bottom - left (2015)
(Img84) Ippocrate's raw rendering simulation from front - top - right (2015)

(Img85) Ippocrate's raw rendering simulation from front - centre - right (2015)
(Img86) Ippocrate's raw rendering simulation from back - centre - right (2015)
(Img87) Ippocrate's raw rendering simulation from front - top - left (2015)
(Img88) Ippocrate's raw rendering simulation from front - centre (2015)
(Img89) A rendering example of just Ippocrate's screen with the "home" manu while working (2015)
(Img90) The final Tree made during erasmus project (2015)
(Img91) Some rendering example of the Ippocrate's App sub-menus (2015)
(Img92-93-94) Some ex. of the round-shape graphics for digital clock, statistics and music navigation
(Img95-96-97) Some ex. for an App about events, an App about daily organization and one about work's organization
(Img98) Main Ippocrate's menu with all the parameters inside the limit values (2015)
(Img99) Main Ippocrate's menu with one parameter very out of the limit values (2015)
(Img100) Main Ippocrate's menu with one parameter very out of the limit values and one other slightly out of them (2015)
(Img101) Datas Ippocrate's menu with the selected parameter inside the limit values (2015)
(Img102) Datas Ippocrate's menu with the selected parameter slightly out of the limit values (2015)
(Img103) Datas Ippocrate's menu with the selected parameter very out of the limit values (2015)
(Img104) The five different screens for Ippocrate's sub-menus (2015)
(Img105) The five different wireframes for Ippocrate's sub-menus (2015)

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