HCI Report

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Contents

1 Executive Summary

The following document describes the process of creating the E-Helmet smart helmet and smartphone application. The main goal of the project, which was carried out following the Double Diamond technique, is to mitigate the risks cyclists face on a daily basis while on the bike [1].

After deciding what problem to tackle, we thoroughly analyzed the existing solutions through the technique of benchmarking, which we found to be useful not only because we managed to get an overview of the products that are already out there, but also because we were able to draw inspiration from these designs.

We then interacted with users to gain further insights into the issue. We used triangulation of data, methodological triangulation, and investigator triangulation through interviews, questionnaires and observations. Leveraging data analysis techniques such as thematic analysis, we were finally able to define personas and scenarios, and later, we stipulated a list of functional and non-functional requirements. The most interesting features we decided to add are automatic turning lights through a brain computer interface and a head-up display containing all the information the users want.

Having in mind a clear list of features to implement, we developed a low-fidelity prototype, which we evaluated with the users by having them complete a series of tasks and compile the SUS questionnaire at the end. In addition to that, we tried to objectively assess the usability of the system through heuristic evaluation. After analyzing the results of the evaluation of the first prototype, we developed a medium-fidelity prototype in Axure. This prototype not only addresses the shortcomings of the low-fidelity prototype but is also closer to what we envision our final product will look like. Finally, we evaluated the medium-fidelity prototype similarly to how we did it for the low-fidelity one.

2 Benchmarking

Being passionate about cycling, we decided to tackle the issue of road safety. After an intense brainstorming session, during which all proposals were presented and discussed, a general and abstract idea of an e-helmet was born: a revolutionary bike helmet designed to safeguard cyclists' lives while enhancing their experience by making it simpler and more intuitive.

To achieve this, we began by analyzing existing solutions in the market, starting with a benchmarking phase, to inspire us and understand the strengths and weaknesses of competitors in order to create a better product. Specifically, on our competitors' chart axes of features and security, we evaluated how each product protects the cyclist and, at the same time, what features and customization it offers, such as navigation systems, health monitoring sensors, and integration with mobile apps were considered. Security aspects involve assessing how effectively the product safeguards the cyclist. Here are the products taken into consideration:

Garmin smartwatch

This smartwatch offers a lot of functionalities in a very compact form. Not only is it able to record activities through GPS signal, but it also displays a lot of useful information such as the heart rate and the time.

Bryton bike computer

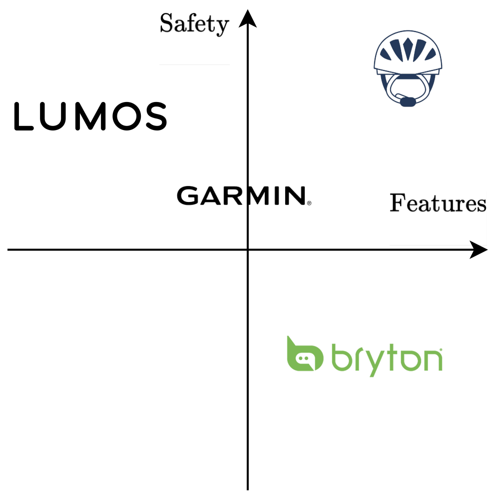
Bryton offers a nicely designed bike computer, which shows data such as speed and heart rate. In addition to that, it registers activities and is compatible with most bike radars and power meters. Another interesting feature is the accident detection: whenever a strong collision is detected an emergency message is sent automatically to a few selected numbers. The feature we find most interesting though is the back radar: whenever a car approaches from behind the user is warned with a beep sound.

Lumos

Lumos is a smart helmet with front and back lights that make the user visible at 360 degrees. The most interesting feature is the wirelessly activated turn signals: there are two blinking lights on either side of the helmet that activate when the user clicks a button.

2.1 Solutions comparison

Finally, here is the comparison between our product and the competitors plotted in a plane where the y-axis represent safety and the x-axis the number of features.



2.2 Design space

Using the predefined icons, dimensions, and features in Axure, we created an initial design. For the font, we decided to use Open Sans, which is one of the most commonly used fonts, according to the Google Fonts page.

Regarding possible designs, we noticed that in the last couple of decades, there have been many innovations in cycling products centered around performance, such as lighter and more aerodynamic bikes and helmets. For this reason, we wanted to create something that focuses more on security, hoping to create a trend that encourages more cyclists to prioritize their safety.

Figure 1: E-helmet during a turn.

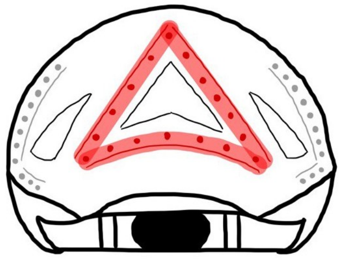


Figure 2: E-helmet while braking.

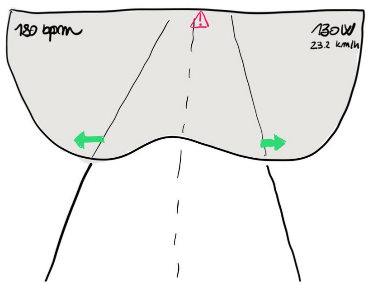


Figure 3: HUD possible design.

Since there has been a lot of innovation in recent years in brain-computer interfaces, we thought of automatically activated safety features, such as accident detection and turning lights, which are shown in Figure 1. Another interesting prospect is the implementation of braking lights on the helmet, which consist of red LEDs that brighten up when the user brakes, as displayed in Figure 2.

Moreover, bike computers are as popular as they are distracting, so we thought of introducing a head-up display in the helmet, like the one shown in Figure 3. This concept also implements the idea of a back radar: the red warning sign at the top indicates when a car is approaching.

Last but not least, the color ought to be bright, possibly white since it is the most reflective color. Speaking of the helmet, it should adopt the MIPS technology since it can enhance security in case of an accident.

3 PACT Analysis

The next section will present the PACT analysis, a method used to break down complex design problems. This analysis has been a recurring reference point throughout the project.

3.1 People

Our product is targeted at people who practice cycling at any level, from total beginners to professional riders.

The **primary user** is the cyclist who uses the smart helmet to feel safer during their rides and to check the details of their activity afterwards.

The **secondary users** are those interested in the details of the cyclist's activities. This includes trainers, who use the app to review the cyclist's performance data, such as speed, heart rate, and distance traveled, and friends, who are simply interested in knowing what their friends are up to on the bike.

The **tertiary users** include the friends and family of the cyclist who will be affected by the presence of the smart helmet to some degree. They benefit from the increased safety of the cyclist, experiencing less worry about their loved one's well-being while they are riding. Additionally, drivers, pedestrians, and other cyclists may be indirectly affected by the presence of the smart helmet, as its safety features contribute to overall road safety, potentially preventing accidents and improving communication among road users.

3.2 Activities

The purposes of the activities can be categorized in two main groups: safety and activity tracking. The **safety features** are the following:

- Automatic turning lights through brain computer interface, which means that when the user thinks of making a turn, the blinking light will be turned on.
- Head up display, which shows information regarding the maps and statistics such as power and heart rate in a non distracting fashion.
- Back radar which warns the user of oncoming traffic through haptic and auditory feedback.
- Crash detection device which sends an emergency message to selected contacts upon a strong collision.
- Rear lights that brighten when the user brakes.

In addition to that, the device allows the user to record activities and keep track of information such as speed, heart rate, and power.

Taking all of this into consideration, it is easy to see that the device serves both pragmatic and hedonic purposes. It is used regularly and without time pressure, continuously from the moment it is put on. It tracks activity over time and operates cooperatively - other cyclists hear the device beep when a car approaches from behind, and drivers can see the blinking light when it activates. Its safety is critical, as any system malfunction, such as the automatic turning lights, could potentially lead to an accident.

3.3 Context

The context in which the device is used is on the bike cycling on a shared road with car users.

The activities are usually carried out individually, although it is common to have arbitrarily large groups of cyclists together.

The psychological context is quite intricate. Users often find themselves in stressful situations due to physical exhaustion from cycling and anxiety caused by unsafe overtaking by road users.

Additionally, cyclists may experience added stress when navigating unfamiliar areas, needing to determine their route.

3.4 Technology

Our smart helmet processes a great deal of data, both in input and in output. Here is the list of all the data in **input** and its purpose.

- GPS signal: Used to show the position of the user on the map and track the activity.
- Back radar: Checks for approaching cars from behind.
- Brain waves: Analyzed to understand whether the user is thinking of making a turn.
- Third-party sensors (e.g., heart rate, power, cadence).

And here is the list of all the data in **output** and its goal.

- Haptic and auditory signals from the back radar: Warns the user of an oncoming car.
- Signals for activating turning lights based on brain wave analysis.
- Information displayed on the head-up display from the third-party sensors.

3.5 Data gathering

Now comes perhaps the most crucial aspect of the project: user interaction to understand their needs, challenges, and concerns. This step is particularly essential because engaging with users has enabled us to gain deeper insights into the issues and develop a solution tailored to cyclists' needs.

To achieve this thoroughly, we used triangulation of data, methodological triangulation, and investigator triangulation, meaning that various data-gathering experiments were conducted by different researchers with diverse groups of people.

The data was gathered through observations, questionnaires and interviews.

Questionnaire

The objective of the questionnaire was to gather data from a large population by administering a series of concise questions. Specifically, we wanted to understand what types of devices cyclists use for both safety and pleasure. Additionally, we wanted to determine if road safety, the problem we were addressing, was a concern for the users. Therefore, we asked participants how safe they feel while cycling and how they navigate critical maneuvers, such as turns.

Before we published the questionnaire, we conducted a small pilot study. During this pilot study, we identified some minor issues related to ambiguous questions and clarity.

The form was shared in the FantaCycling Telegram group in order to reach people who ride their bike for fun. Most questions utilized a Likert scale ranging from 1 to 5, enabling us to quantify qualitative data and simplify the questionnaire for respondents. We also reduced the number of questions to the bare minimum to avoid bothering the user too much because when presented with too many questions, users might either start responding randomly or abandon the questionnaire altogether. A total of 101 people responded, with 92 males and 9 females. The age distribution, shown in Figure 4, and self assessed level of cycling (Figure 5) are shown in the accompanying pictures. Almost all respondents (95.9%) identified as cyclists, with 84.2% cycling at least once a week.

Most respondents asserted that they **do not feel safe** on their bikes, as shown in Figure 6: 30.6% feel very unsafe, 46.3% feel somewhat unsafe, and 23.2% feel more safe than unsafe. Therefore, it is reasonable to assume that most cyclists feel unsafe, indicating that the road safety problem being investigated in this research is real.

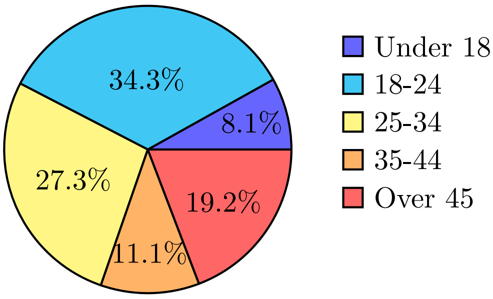


Figure 4: Age distribution

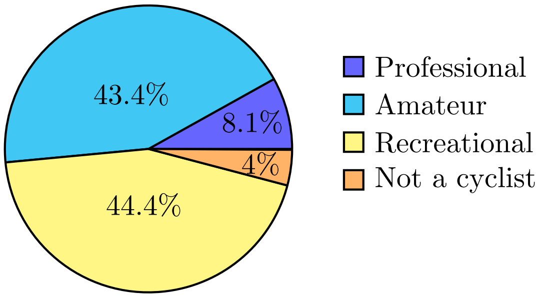


Figure 5: Cycling level distribution

The overwhelming majority of respondents (93.7%) affirm that they are very aware of their surroundings. Consequently, we decided to drop the idea of implementing rearview mirrors.

Regarding the most popular leisure devices, 37.9% of respondents use a smartwatch, 64.2% use a bike computer, 51.6% use a heart rate sensor, and 52.6% use GPS. For safety, almost everyone (93.7%) uses a helmet. Additionally, 63.2% use a rear light, 37.9% use a front light, 20% use an accident detection sensor, and 15.8% use a rear light radar.

Interestingly, people reported indicating their intention to turn most of the time: 49.5% always do it, 33.7% almost always do it, and the remaining portion does it with varying levels of frequency. We suspect this finding may be inaccurate because respondents might have answered slightly dishonestly to avoid feeling embarrassed. Therefore, we decided to further investigate this by observing the users in the field. More information can be found in the dedicated section.

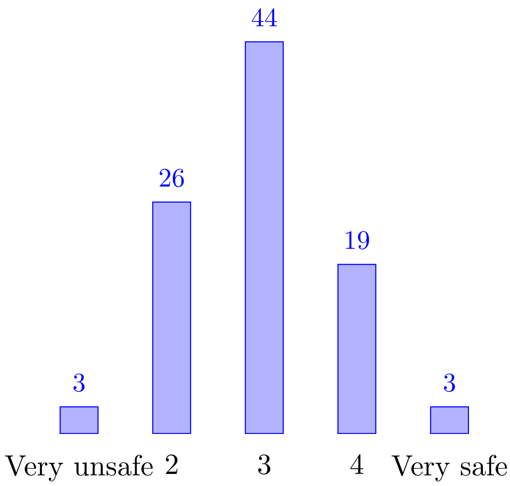


Figure 6: How safe do you feel?

Interviews

After administering the questionnaire, we contacted some cyclists who left their contact so as to conduct an interview. The interviews were semi-structured and the questions goal was to understand whether the interviewee felt safe on the bike and if they feel at ease during a maneuver, and more in general to understand the user as much as possible.

In total, we interviewed 9 cyclists, all males between 20 and 35 years old, coming from different parts of Italy (Trento, Turin, Garda Lake), and the world (Germany, Dubai). Needless to say, all interviews were consensual and notes to carry out thematic analysis were taken.

Observation

As anticipated earlier, an indirect passive field observation was conducted to test whether cyclists indicate their intention to turn. We recognized that directly asking cyclists if they indicate may introduce bias, as they might feel embarrassed to admit not following the rules. Therefore, alongside asking cyclists in the questionnaire about their signaling behavior and querying about their sense of safety during maneuvers in the interviews, we observed their actual signaling behavior. Figure 7 shows the differences between questionnaires and observations data.

We stationed ourselves at a busy intersection on Via della Gotarda, Mattarello (TN), where we observed and filmed cyclists' signaling behavior before turns. A total of 25 cyclists passed by: 7 professionals, 10 amateurs, and 8 bike packers. While we did not directly ask about their categorization, we are confident in our estimations. For instance, the third group of cyclists in the first video were assumed to be professionals based on their jerseys and very expensive gear, which were of the professional cycling team "Lidl Trek".

Out of these 25 cyclists, **18 did not signal**, which is significantly different from the data collected via questionnaires, where 49.5% reported always signaling their turns and 33.7% indicated they almost always do so.

In light of all these observations, we decided it was a good idea to implement automatic turning lights through brain computer interface.

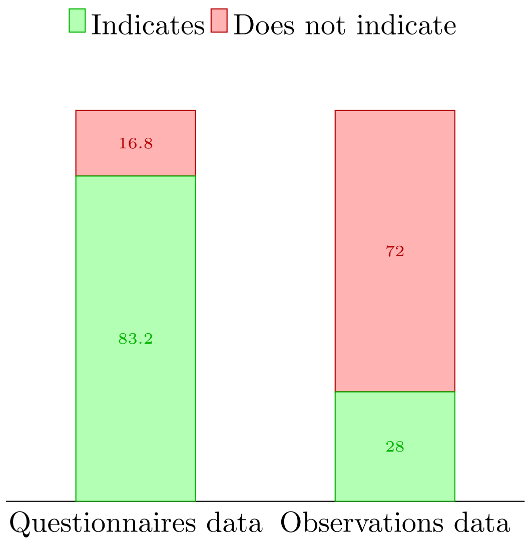


Figure 7: Difference between questionnaires and observations data

3.6 Data analysis

After conducting the interviews, we performed the so-called thematic analysis, in which each researcher read the transcripts and identified recurrent themes to create a list of user requirements. After completing this process, we compared and agreed on the themes we found to be most significant, which are the following:
All interviewees feel unsafe and use the helmet.
6 out of 9 use the bike computer and admitted that it **tends to distract** them while riding:

- *"Sicuramente mi capita di distrarmi, [...] capita che abbassi la testa sul ciclocomputer per capire dove devo andare e per cui mi distraggo un attimo."*
- *"Il ciclocomputer è distraente e un po' scomodo da usare per la posizione in cui sono e per i tasti da premere."*
- *"Secondo me la cosa che più ti distrae è guardare il ciclocomputer e non stare attento a quello che ti circonda, infatti l'anno scorso ho avuto un incidente appunto per questo: c'era una macchina ferma davanti a me e l'ho toccata."*.

Based on this data and the fact that most people reported using a bike computer in the questionnaire, we came up with the idea of a non distracting head-up display.
3 out of 9 interviewees mentioned having issues with using the maps:

- *"Il mio computer non è cartografico [...] per cui capita spesso che io sbagli strada."*
- *"Una cosa che odio del mio ciclocomputer sono le mappe, perché se devo impostare le mappe ci vuole molto tempo [...], è una cosa complicata."*.

Given that people are dissatisfied with the current map functionality, we thought of implementing map directions on the head-up display.
2 out of 9 interviewees expressed frustration with the way turn maneuvers are currently executed:

- *"Tenere l'equilibrio usando il braccio come freccia [...] risulta un po' difficile. Hai un braccio in meno per cui non ho pieno controllo della bici."*
- *"Se una curva è pericolosa [...], non metto il braccio fuori perché è pericoloso, per cui indico solo con il gomito. Per me è rischioso togliere le mani dal manubrio."*

From these interviews, we understood that cyclists do not feel safe taking their hands off the handlebars. Combining this with the observed tendency for laziness, we decided to implement automatic turn signals through a brain-computer interface.

3.7 User requirements

After gathering and analyzing the data, we went through a brainstorming session to define the requirements based on this data. Following this, we used innovation and creativity to generate, refine, and develop additional ideas.

Functional requirements

- The head-up display must display the information given by the bike computer, including directions.
- The helmet must give haptic, auditory and visual feedback when a car is approaching.
- The helmet must turn the blinking lights on when the user thinks of making a turn.
- The helmet must detect that an accident has occurred through accelerometer data and brain data.
- The helmet must register the data of the activity: speed, heart rate...
- The helmet's back lights must brighten when the user breaks.
- The app must show the data of the activity to the user.
- The app must allow the user to connect to the main fitness apps.
- The app must allow the user to decide which data to show on the head-up display.

Non functional requirements

- The head-up display UI must be non-distracting.
- The user must feel at ease while making a turn.
- The app must be easy to use.

The main reason we decided to create an app alongside the smart device is that, when offering many AI capabilities such as automatic light control and accident detection, it is important to give users the ability to decide how much control to have. This is especially true given that the e-helmet is **proactive**, making decisions on its own based on collected data. In fact, it is **context-aware** because it understands when an accident has occurred based on contextual data such as the accelerometer, brain waves and GPS. It also offers **implicit interactions** by analyzing brain data, automatically actuating the blinking lights, and confirming it in the HUD via a green arrow.

4 1st Iteration

4.1 Personas

After the data analysis and the definition of the user requirements, we defined some personas that represent the typical user of our smart helmet.

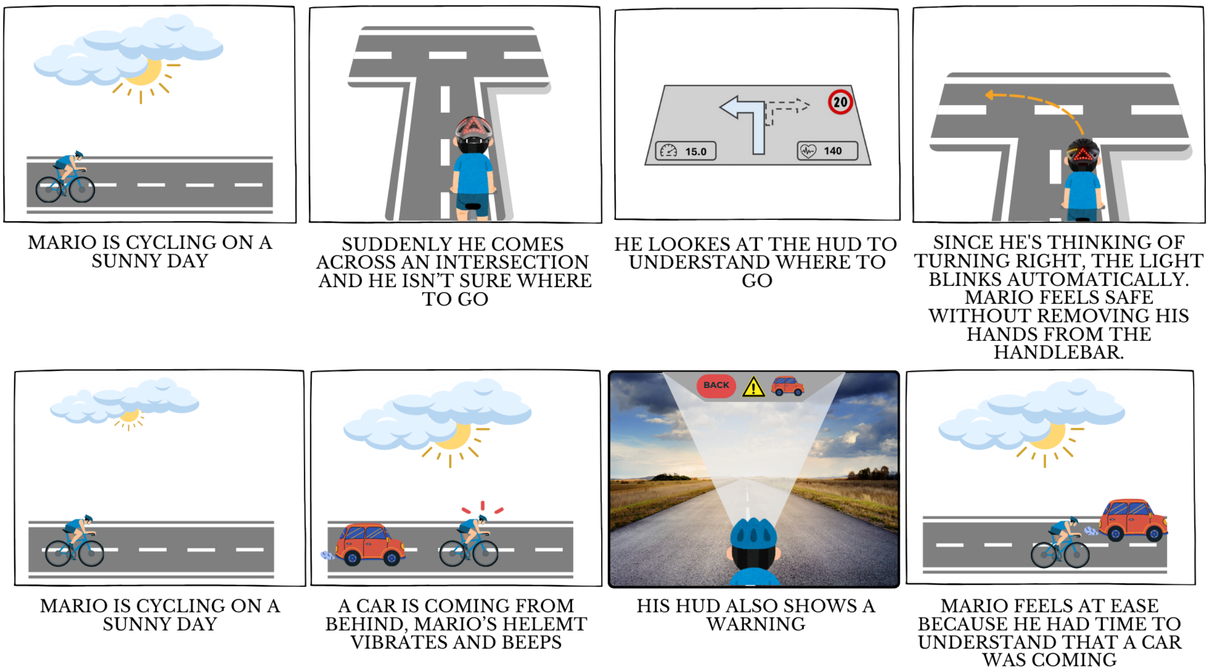
Amatuer cyclist Luca Bianchi, a 24-year-old university student residing in Trento (Italy), has been cycling since childhood, initially joining a cycling club in first grade and participating in youth categories. Despite a hiatus due to academic demands and training volumes, since 2020, Luca has resumed cycling more consistently, typically riding twice a week. He prefers nearby climbs for training, utilizing bike paths for convenience and safety while avoiding busy roads. His goal is to maintain excellent physical fitness and continuous improvement, however he would like to be safer during his weekly rides.

Bike packer Davide Conti, 29 years, lives in Dubai (UAE). His passion for cycling originated from "family bike rides" and intensified over the last years, initially by following cycling on TV and then by practicing it. In general, he trains by cycling in Dubai and also on various European roads. He frequently goes bikepacking with work colleagues or friends, exploring unfamiliar routes. He is interested in discovering new cycling routes and integrating cycling into everyday life, seeking to have greater security on his long journeys.

Professional cyclist Marco Rossi, 20 years old, lives in Italy and he is a dedicated competitive cyclist for the professional team Intermarché-Wanty. He began cycling at a young age, initially training in controlled environments before progressing to open roads with traffic. Marco has been actively involved in competitive cycling for several years and he also frequently participates in training camps in various countries, including Spain, Belgium, Italy, France, and Croatia. Marco's rigorous training regimen includes both solo and team sessions, often utilizing local climbs and bike paths for safety and convenience. His primary goal is to train in safer conditions to achieve the best possible results in professional cycling competitions.

4.2 Scenarios

Having defined the personas, we moved on to a brainstorming session in which we generated ideas based on the requirements that emerged in the data analysis. After agreeing on the ideas, we had a clear conceptual design in mind, which we used to create envisioning scenarios for our personas.



4.3 Low-fidelity prototype

Having defined the scenarios and personas, we moved on to creating a low-fidelity prototype. We designed it following the **design principles** and **heuristics**, as well as the principles of **universal design**. We made a **horizontal compromise**, aiming to include as many features as possible for usability testing. Specifically, we devised a paper prototype: some of its pages are shown below.

We created a welcoming page to elicit positive emotions at the visceral level, making users feel welcome to our app. From the welcome page, Figure 8, users can navigate to the login/signup

Figure 8: Welcome page

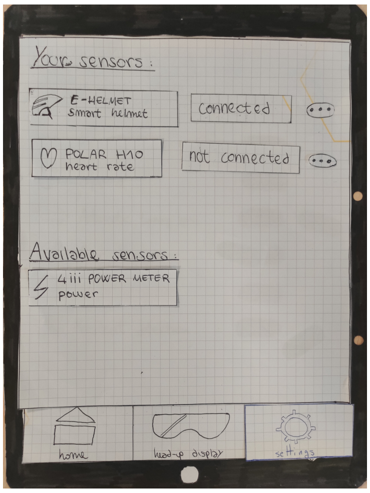


Figure 9: Your sensors page

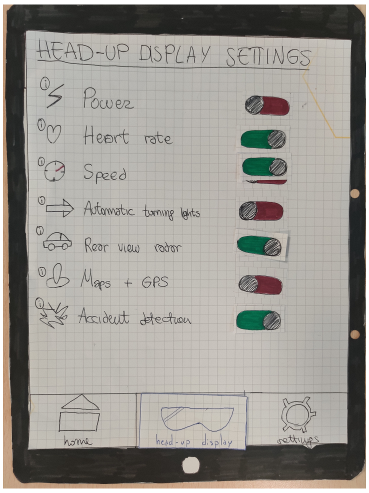


Figure 10: HUD settings page

pages through two large buttons. According to Fitts's Law, when touch targets are too small, users take longer to tap them. To avoid any inconvenience and prevent negative emotions, we ensured the buttons were large and easy to tap, thereby making the login process as frustration-free as possible.

The login/signup pages were designed similarly, following the Gestalt principle of proximity. There are two distinct groups: one for logging in/signing up with Google and one for doing so via email.

Once the login/signup process is completed, users are redirected to the home page, which displays their recent activities. Here, we again applied the Gestalt principle of proximity to clearly associate descriptions with their respective activities.

In the settings, we included two large buttons (Following Fitt's law): one redirects to the page for connecting a device, and the other to the page for connecting a sensor. On the device connection page, Figure 9, we presented information structurally, adhering to the Gestalt's principles of similarity and proximity.

In the HUD settings, Figure 10, users can choose what to display. We wanted to make it clear whether a setting was on or off, so we used switches represented symbolically with strong opposing colors and made them large for easy interaction. Furthermore, by combining Gestalt's principles of proximity and similarity, we grouped icons with the corresponding text and switches for added clarity in the presentation.

4.4 Evaluation

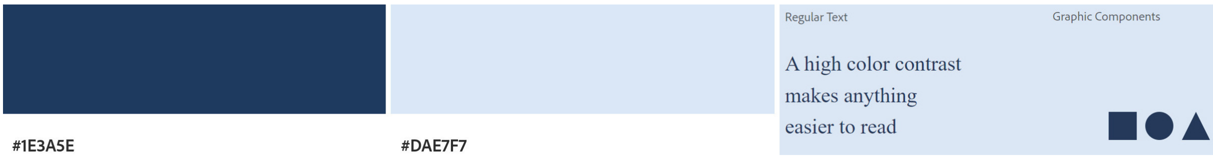
After designing the app, we performed the evaluation with five potential primary users. The users were given some tasks to perform, and while they were carrying them out, they were invited to **speak aloud** (unfortunately most users did not speak as they were not comfortable with it), following the think-aloud technique. Since the prototype was on paper, we used the **Wizard of Oz technique**, where one researcher acted as the computer. After the evaluation, the users completed the SUS questionnaire. We also quantitatively assessed the performance of our system by measuring the percentage of successfully completed tasks. Finally, we conducted a heuristic evaluation of the prototype to understand how perceivable, operable, understandable, and robust our system was.

The users appeared confident navigating the app, successfully completing the tasks 85.7% of the time. The average SUS score was quite robust at 76.5 with a standard deviation of 5.76. However, from the usability testing and the heuristic evaluation, we noticed that users had some trouble disconnecting a sensor on the "Your sensors" page because the three dots were not recognized as a menu. We also identified some errors attributable to the low quality of the prototype: some users could not see the "i" icon alongside the symbols on the "Head-up display settings" page, and some did not understand that they had to scroll to view more information on the activity page.

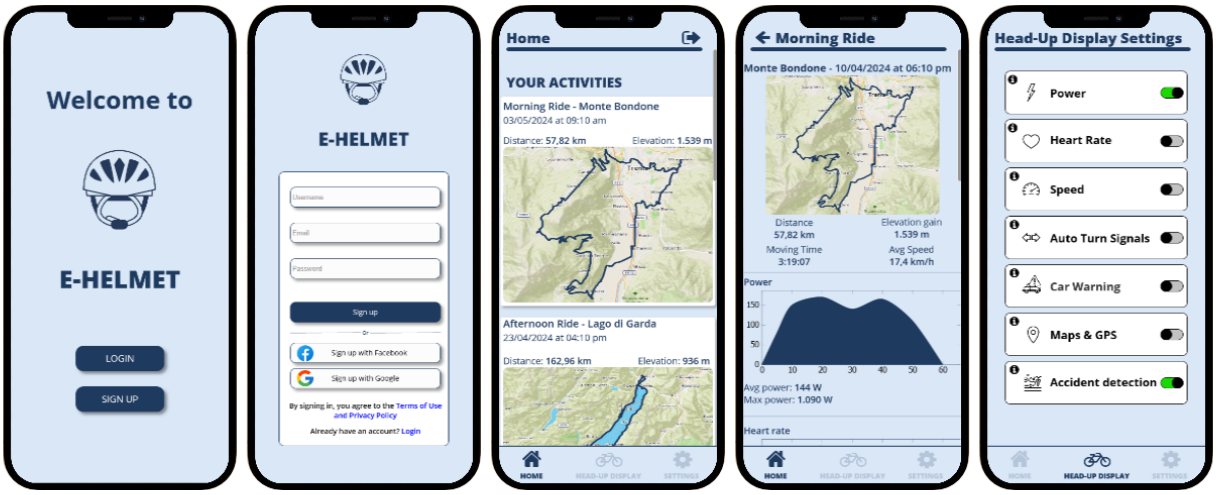
5 2nd Iteration

5.1 Medium-fidelity prototype

After evaluating the paper prototype, we refined it by creating a more detailed application using the software Axure, which allows for more complex interactions that were impossible to represent on paper. A video of the app and the HUD showcasing it can be found here.



Regarding the color scheme, we used the Adobe color palette to generate a monochromatic color scheme. The primary color is an elegant dark blue (1E3A5E), complemented by a lighter hue (DAE7F7). We then used the color blind checker and contrast checker to ensure there was enough contrast and that color blind users would not struggle to distinguish between colors. Here are some examples of the medium-fidelity prototype:



Having done that, we fixed the two main issues found in the evaluation of the low-fidelity prototype. Since some users did not understand that the three dots on the "Your sensors" page opened the menu to connect or disconnect a sensor, we replaced them with two buttons labeled "Connect" and "Disconnect." Moreover, we made the "i" icons in the "Head-up display settings" larger so they would be easier to spot.

The welcome page remains unchanged; we simply improved it by adding colors. We enhanced the login and signup pages by implementing Gestalt's principle of focal point: the "login" and "signup" buttons are now colored with our main color to encourage users to click them and use our app. Additionally, we added error messages, ensuring they were the only red messages in the app and not only explained the error but also provided suggestions on how to fix it. For example, if the password is too short, the message "The password field must contain at least six characters" appears. We also ensured the error messages were as close as possible to where the user was focusing, and that the source of the error, in this case, the text box, visibly wiggled and displayed an error symbol.

The home page has also greatly improved: the maps are now interactive thanks to the tool Scribble Maps.

On the settings page, we made the two buttons large and spaced well enough to avoid accidental taps and ensure users take little time to tap on them, as Fitts's law indicates. We applied the same principle on the "Connect an app" page.

On the "Connect a sensor" page, we added an animation that indicates to the user that a sensor is actively being searched for. This ensures that the user knows the app is actually doing something, making it feel more "alive" and responsive.

Regarding the head-up display prototype [1], we simply placed the information selected by the user in the "Head-up display settings" at the two top corners. Additionally, we added a green arrow that blinks at the bottom right and left corners when the brain-computer interface activates the turning lights. Finally, we added a blinking red warning sign at the top to indicate that a car is approaching. The reason these signals blink is that any movement in our visual periphery, even slight, is likely to draw our attention — and hence our fovea — toward it.

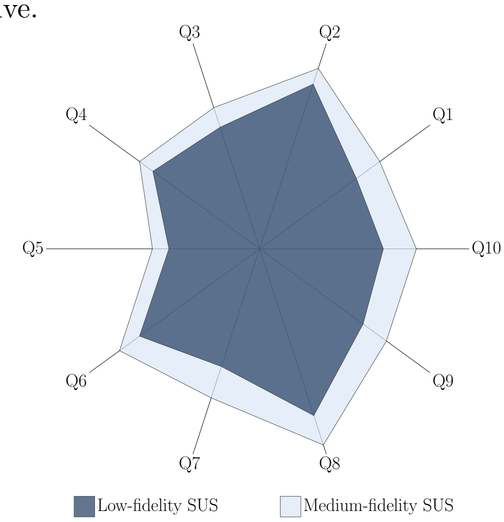


Figure 11: Low vs medium-fidelity SUS

5.2 Evaluation

Having completed the medium-fidelity prototype, we tested its usability with five potential primary users of the app. The users were given some tasks very similar to the low-fidelity evaluation to perform, and while they were carrying them out, they were invited to speak aloud, following the think-aloud technique. After the evaluation, the users completed the SUS questionnaire. Finally, we also evaluated the app through the heuristic evaluation. To sum up, we conducted an evaluation very similar to the one we did for the low-fidelity prototype.

Analogous to the first iterations, the users appeared confident navigating the various sections of the app, successfully completing 94.3% of the tasks. The average SUS score slightly improved to 85, with a standard deviation of 5. From Figure 11, it is possible to see the solid improvement between the low and medium-fidelity prototype: each Q represents the average score of a question where each even numbered question has been inverted in order to make it simpler to visualize it. Table 1 shows the raw results.

From the heuristic evaluation and usability testing, we noticed two minor issues: most users opened the home section when asked to log out, and the scrolling mechanism was a bit awkward because the interactive maps got in the way.

	μ SUS	σ SUS	%tasks
Low	76.5	5.75	85.7
Medium	85	5	94.3

Table 1: μ and σ SUS and % of tasks completed for the two prototypes.

6 Conclusions

This chapter marks the end of the project, completed after the evaluation of the medium-fidelity prototype. While the project is by no means complete and can be further improved, we are satisfied with the way it turned out.

[1] A visualization of this is shown in the demo.

In one instance, we were limited by Axure. Despite spending a lot of time trying to implement touch feedback, we were not able to make it work on some devices, such as the iPad. This inconsistency is an unfortunate limitation because touch feedback would have made the prototype more responsive. However, this is not a major problem, as it can be easily fixed in the real application. By "touch feedback," we mean the feature in most modern applications where a visible indication, like a color change or a grey shadow, shows that an icon has been touched.

Since the issues identified in the second evaluation were minor and easy to adjust, we addressed them. We added a logout button on the home page, where most users expected to find it. Additionally, we replaced the interactive map on the home page with a screenshot to make it easier and quicker for users to navigate. This change provides a larger target area to initiate scrolling, reducing the time and effort needed to steer through the app's interface, according to the steering law. These changes can be observed in the medium-fidelity prototype in Axure. To see the final prototype of the app and how it integrates with the head-up display, watch the following video.

Before the beginning of this project, we were two typical developers who believed that designing a system with a great UI/UX was something only inherently talented designers could achieve. Not only have we changed our minds, but we also feel more confident than ever in our ability to design great applications. We learned many concepts and techniques that made the design process seem achievable rather than insurmountable. Most importantly, we learned the value of interacting with users to better understand their needs and challenges. However, we are fully aware that we still have much to learn and hope to continue improving in the future. Last but not least, we realized the importance of teamwork in human-computer interaction projects, not only for discussing and combining ideas but also for better organizing the work.

During this long project, we made a lot of mistakes because we were learning as we went along. If we had the chance to go back and redo this project from scratch, or even better, if we get the opportunity to do an HCI project in the future, we are confident we would do an even better job. We have learned many valuable lessons that will not be easy to forget and that we are eager to apply.

References

[1] https://injuryfacts.nsc.org/home-and-community/safety-topics/bicycle-deaths/