PROJECT REPORT GLASS2MASS

CBI.Attract

Glassomer

July, 2024

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INTRODUCTION

The CBI.ATTRACT program is an open innovation challenge-based initiative developed in collaboration with the universities of Bologna, Modena and Reggio Emilia, Almacube, and CERN's IdeaSquare. Throughout this program, five inter-university teams of multidisciplinary students have been engaged in studying advanced technologies funded under the ATTRACT program. The primary goal is to explore and leverage these technologies' potential, identifying new applications that address societal, human, and environmental needs in alignment with the UN Sustainable Development Goals.

This initiative employs a hybrid methodology that integrates the human-centered approach of design thinking with technology-driven innovation processes. The objective is to enhance students' abilities to identify and evaluate technological opportunities that can have significant global and local societal impacts. Additionally, it aims to nurture an entrepreneurial mindset among students, equipping them to become future innovators in their respective fields.

The CBI.ATTRACT program is a crucial component of the broader ATTRACT Academy, encompassing ten student programs funded under the ATTRACT initiative. Supported by the European Commission's Horizon 2020 research and innovation program, the ATTRACT Academy's student projects aim to cultivate a stronger entrepreneurial culture across Europe. By leveraging research-based concepts and technologies, these projects seek to develop innovative products and services that cater to the needs of citizens. The program not only fosters technical and entrepreneurial skills but also encourages a collaborative and multidisciplinary approach to solving real-world problems.

OUR TEAM

The Glass2Mass team consists of Master's students with diverse skill sets and backgrounds, forming a multidisciplinary group. Their complementary skills significantly contributed to the final product, as each member brought a unique perspective, enabling the team to have a comprehensive 360-degree view of each problem. Beyond their professional approach to work, the team developed strong personal connections and friendships, adding additional value to the project.

ELOISA MAZZOCCO

A Digital Automation Engineering student, was a cornerstone of the project team, bringing her extensive professional knowledge and experience to the forefront. She not only contributed significantly to the technical aspects of the project but also served as the main liaison between the group and various experts and potential partners. Eloisa's profound understanding of technology, engineering, and scientific processes enabled her to conduct interviews with industry experts efficiently, gathering crucial information that shaped the discovery and design phases of the project. Her expertise in AI algorithms, software development, and engineering was invaluable during the development phase, where her insightful suggestions elevated the product's quality. Moreover, Eloisa's calm demeanor consistently brought a sense of tranquility to the team, helping to maintain focus and composure during challenging times. Her dual role as a technical expert and a steadying presence made her an indispensable asset to the project's success.

EDOARDO LOLLI

A Mechanical Engineering student, infused the project with both technical precision and creative flair during the idea creation process. His extensive understanding of technology and expertise in conducting scientific research allowed the team to explore alternative approaches thoroughly and methodically. Edoardo's contributions were particularly vital during the development and prototyping phases, where his deep knowledge of engineering principles ensured that technology, most relevant and effective component were incorporated into the final product. Beyond his technical skills, Edoardo's infectious sense of humor and fun-loving nature made him a joy to work with, lifting the team's spirits and creating an enjoyable work environment. At the same time, his ability to maintain discipline and focus kept the team on track, balancing productivity with a positive atmosphere

MANUEL RECH

Manuel Rech, a Statistics student, infused the project with his analytical expertise, meticulously evaluating the implications of each potential solution. His business acumen ensured that the team remained organized and structured, providing a clear framework for the group's efforts. During the discovery and design phases, Manuel's relentless pursuit of data-driven solutions and market-oriented information was invaluable, guiding the team toward informed and strategic decisions. Manuel's sense of humor and lightheartedness kept the atmosphere enjoyable, making the process fun while also maintaining the necessary focus and discipline.

CHRISTIAN SEGRETO

An Advanced Design student, seamlessly integrated his creativity and technical knowledge into the project, driving the team towards the creation of an innovative new product. His relentless focus on pushing boundaries and exploring new possibilities inspired the team to think outside the box, fostering a culture of innovation. Christian's keen sense of aesthetics ensured that the final product was not only highly functional but also visually appealing, and his skills in crafting high-quality resentations showcased the team's progress and achievements at each phase. With an engineering background, he adeptly analyzed problems from multiple perspectives, providing unique insights and diverse solutions. Beyond his professional contributions, Christian's ability to keep the atmosphere light and fun through his engaging videos and role as the group's DJ made the collaborative experience enjoyable and dynamic. His multifaceted expertise and vibrant personality were invaluable to the project's success.

IREM ATMAR

A Digital Humanities and Digital Knowledge student, was an indispensable member of the team, infusing a human-centered approach into every aspect of the project. Her commitment to understanding the technology and conducting thorough research on its technical features was inspiring and set a high standard for the group. Leveraging her extensive knowledge, Irem took charge of the website development in the final phase, creating a detailed, user-centered platform that made the solution feel tangible and market-ready. Her clear focus on the project goals, coupled with a willingness to explore various opportunities for valuable solutions, ensured the team remained innovative and adaptable. Personally, Irem's calming presence and positive attitude brought a sense of lightness to the process, consistently motivating and supporting the team through every challenge.

SONJA VUKASINOVIC

An International Management student, applying her business and management expertise she contributed significantly to the research of the technology, with a particular perspective on the market and business potential of the idea. Havin background in graphic design proved invaluable as she took charge of designing all printed materials and milestone presentations, ensuring they were both professional and visually striking. During the development phase, Sonja's business knowledge was essential in crafting a comprehensive business plan that provided a new strategic direction for the project. Personally, Sonja was the team's optimist, consistently maintaining high energy levels and a positive outlook, which motivated and uplifted the entire group throughout the project's journey.

TECHNOLOGY

Glass2Mass introduces an innovative method to shape fused silica glass using the Glassomer Technology, leveraging UV Nanoimprint Lithography (UV-NIL). This technology allows the creation of complex glass components traditionally made from plastics through 3D printing, injection molding, and nanoimprint lithography. The core of this process involves a polymeric glass nanocomposite that can be molded like standard polymers.

After shaping, the polymeric binder is removed, and the glass particles are sintered into high-purity fused silica glass. This method offers significant energy savings and a reduced carbon footprint, making it a greener alternative to conventional glass manufacturing. Applications span across optical components for electronics, biomedical devices, and high-performance optics.

METHODOLOGY

The methodology for this program employs a hybrid model, combining a human-centered design thinking approach with technology-driven innovation processes. The program is divided into three phases: Discover, Design, and Develop.

01 — Discover

This initial phase uses a technology-driven innovation approach to gain a deep understanding of the technology and identify its key functions. Extensive research helps uncover societal needs that the technology can address. Divergent thinking is encouraged to explore various application domains, resulting in a divergent map that visualizes potential application fields. Following this, a convergent process selects five opportunities, assessing their potential value, target users, and problem-solving capabilities. Interviews with technology and field experts, along with stakeholder analysis, validate these opportunities, ensuring their relevance and feasibility.

02 — Design

The design phase emphasizes design thinking, focusing on the needs and experiences of users. It aims to create a seamless user experience by reconstructing the user journey and integrating the technology into specific contexts. User personas are developed to represent different user types, capturing their characteristics, needs, and goals. These personas help ensure the final product addresses diverse user requirements and preferences. This phase also involves prototyping and iterative testing to refine the user experience continuously.

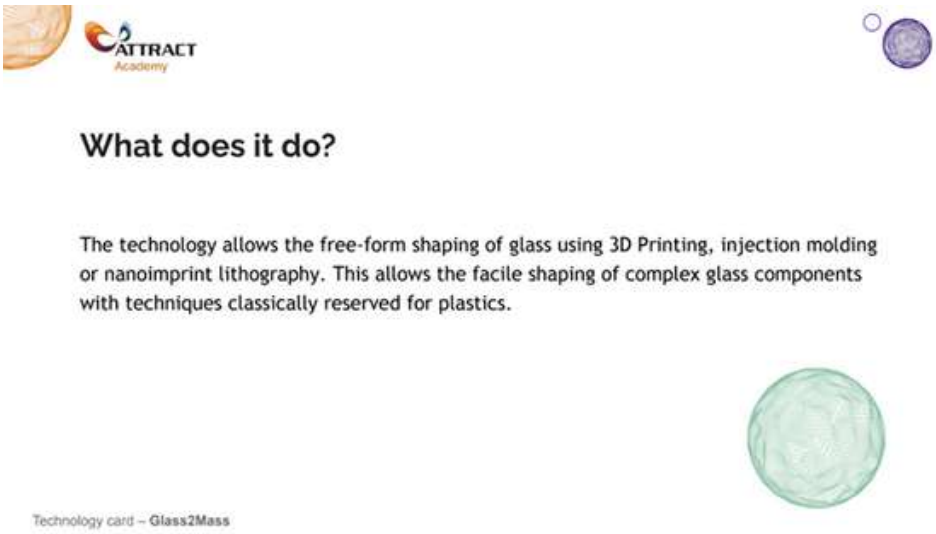
03 — Develop

The final phase is dedicated to transforming conceptual solutions into tangible outcomes. It aims to demonstrate the technology's effectiveness in delivering the intended user experience. This phase focuses on reproducing, testing, and validating the technology's ability to solve the identified need. Extensive testing and validation ensure that the technology performs reliably in real-world scenarios, providing concrete solutions to the problems identified in the earlier phases. This phase also involves finalizing the design for production and preparing for market introduction, ensuring the solutions are ready for implementation.

DISCOVER

Understanding the technology and material

The very first steps to understand the technology were made using the given technology card, we basically took that and tried to contextualize it by doing research and consulting the tech partner website.



Following what the card reported, the main points to be covered to fully understand the technology were:

- State-of-the-art processes used to manufacture glass;
- Standard processes used to manufacture polymers;
- Characteristics of glass and, more specifically, pure silica glass;
- Technical aspects of the technology itself.

Our aim was to ensure everyone had the same base of knowledge to allow non-technical people to efficiently contribute in this phase. The overall approach consisted of:

1. A brainstorming session, in which members with a technical background could share their knowledge about the mentioned points, to align everyone on the basic concepts;
2. Division of the key concepts to research among the members;
3. Another brainstorming session to make sure everyone was aware of all the fundamental aspects.

A brief description of the main concepts learned can be found below:
Etching: A process used to create designs or patterns on the surface of glass by removing a thin layer of material. This is typically achieved through chemical, abrasive, or laser methods.
Grinding: A process that involves the use of abrasive tools to remove material from the glass surface to achieve a desired shape, smoothness, or finish. It typically involves the use of diamond or silicon carbide abrasives.

Laser structuring: a process that uses focused laser beams to alter the surface or internal structure of glass. The laser can create patterns, channels, or microstructures by either ablating the glass surface or inducing localized melting and re-solidification.

Sol-gel: involves creating a colloidal suspension (sol) that gradually evolves into a gel-like network containing both liquid and solid phases. The gel is then dried and heat-treated to form solid glass.

Precision glass molding: is a process where pre-formed glass blanks are heated to their softening point and then pressed into precise shapes using molds. The process is carried out in a controlled environment to ensure high accuracy and repeatability.

Stereolithography (SLA): 3D printing technique that uses a UV laser to cure liquid photopolymer resin layer by layer. The laser traces a pattern, hardening the resin, and the build platform lowers for each new layer.

Selective Laser Sintering (SLS): 3D printing technique that employs a laser to sinter powdered materials, like thermoplastics and metals, layer by layer. The powder bed provides natural support, eliminating the need for additional structures.

Fused Deposition Modeling (FDM): 3D printing technique that extrudes thermoplastic filaments through a heated nozzle, depositing material layer by layer.

Digital Light Process (DLP): 3D printing technique that uses a digital light projector to cure layers of photopolymer resin simultaneously.

Multi Jet Fusion (MJF): 3D printing technique that involves an inkjet array that applies fusing and detailing agents to powdered material, which is then solidified by infrared light.

CNC machining: process that involves the use of computer-controlled machines to remove material from a solid block (often called a blank or workpiece) to create the desired shape. The process uses various cutting tools, such as drills, mills, and lathes, guided by precise computer instructions to achieve high accuracy and repeatability.

UV casting: comprehends creating parts by curing liquid resin with ultraviolet (UV) light. Typically, a silicone mold is used, and the liquid UV-curable resin is poured into the mold. UV light then cures and solidifies the resin, forming the final part.

Injection molding: implies injecting molten material into a mold cavity, where it cools and solidifies into the final part. The process starts with heating the material (typically plastic) until it becomes liquid, then forcing it into a mold under high pressure. Once the material cools and hardens, the mold opens to release the part.

Sintering: Process of compacting and forming a solid mass of material by pressure or heat without melting it to the point of liquefaction. Sintering happens as part of a manufacturing process used with metals, ceramics, plastics, and other materials. The nanoparticles in the sintered material diffuse across the boundaries of the particles, fusing the particles together and creating a solid piece.

Material: fused silica glass - amorphous silicon dioxide
In the following section a short recap on the material properties can be found.

PHYSICAL PROPERTIES

1. **Chemical Composition**: Consists almost entirely of silica (SiO2), typically 99.9% or higher purity.
2. **Density**: Typically ranges from 2.2 to 2.3 g/cm^3.
3. **Transparency:** Transparent across a broad spectrum from ultraviolet (UV) to infrared (IR) wavelengths.
4. **Refractive Index**: Generally around 1.46 to 1.48, depending on the wavelength of light.
5. **Melting Point:** Approximately 1650 to 1700°C (3000 to 3100°F).
6. **Thermal Expansion Coefficient:** Low coefficient of thermal expansion, approximately 0.5 x 10^-6 /°C.
7. **Softening Point:** Typically around 1683°C (3061°F).
8. **Thermal Conductivity**: Relatively low thermal conductivity compared to metals.
9. **Heat Resistance:** Can withstand continuous exposure to temperatures up to 1000°C (1832°F) without significant deformation or softening

MECHANICAL PROPERTIES:

1. **Hardness:** Fused silica is relatively hard and resistant to scratching.
2. **Tensile Strength**: High tensile strength, but relatively brittle.
3. **Compressive Strength:** High compressive strength, able to withstand high pressures.
4. **Flexural Strength:** Moderate flexural strength, but can be susceptible to fracture under certain conditions.
5. **Modulus of Elasticity:** High modulus of elasticity, providing stiffness and dimensional stability.

ELECTRICAL PROPERTIES:

1. **Dielectric Constant:** Low dielectric constant, making it suitable for high-frequency applications.
2. **Dielectric Strength:** High dielectric strength, making it suitable for electrical insulation in high-voltage applications.
3. **Electrical Resistivity:** High electrical resistivity, providing insulation against electrical current.

OPTICAL PROPERTIES:

1. **Transmission**: Excellent optical clarity and high transmission across a wide range of wavelengths, from ultraviolet (UV) to infrared (IR).
2. **Index of Refraction:** Low refractive index compared to other optical materials, such as glasses and crystals.

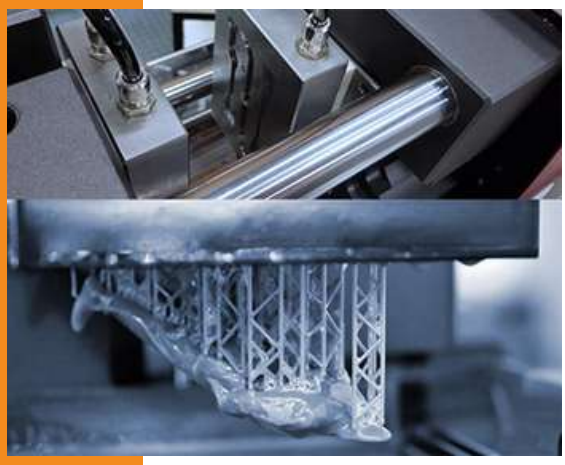
CHEMICAL PROPERTIES:

1. **Chemical Inertness:** Highly inert to most chemicals, including acids, alkalis, and organic solvents.
2. **Corrosion Resistance:** Excellent resistance to corrosion and chemical attack, even at high temperatures.
3. **Hydrolytic Stability:** Highly stable in humid environments and resistant to water absorption.

Having fixed these ideas in mind, we also consulted the Glassomer website to finally understand the specifics of the technology itself. The main steps of the process to shape fused silica glass, according to the partner page, are:

I MAKING THE GLASSOMER COMPOSITE:
depending on the process, Glassomer composites are liquid or solid. To produce them, glass powder and organic binder matrix are combined in the first step. The effective compounding is key to ensure a homogeneous mix of liquids and solids. The process takes place under clean conditions to avoid the inclusion of dust in the material.

II SHAPING:
the solid composites are shaped by injection molding on a regular polymer injection molding machine at 130°C. Liquid composites are shaped by 3D printing or casting on molds. The shaped and hardened composite parts appear whitish due to the high solid loading. The parts behave like polymers so that the removal of sprues and supporting structures is easy.



III SINTERING TO GLASS :
the shaped parts are processed in an oven at 600°C to remove the binder. Glassomer managed to develop a binder mix that allows for processing of thick parts - 15 mm are regularly done, more is possible - without breaking. Parts are then sintered at 1300°C to give fused silica parts of full density. The shape is fully retained and the shrinkage is isotropic.

In light of these evidences, the **main strengths** of this breakthrough technology are:

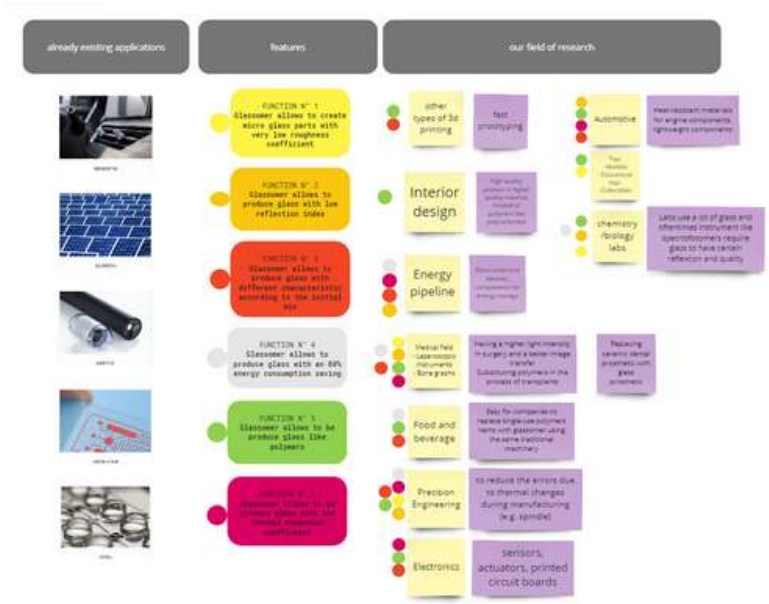
- Durability;
- High purity;
- Great precision of work, from the size of a human hair to the size of a person, with maximum thickness of 3.5 mm;
- Transparency;
- Recyclability of the material and almost fully reusability of the polymeric binder;
- Design freedom.

To conclude, The Glass2Mass technology offers numerous opportunities across various fields due to its unique capabilities. First, it enables the creation of microparts with extremely low roughness, ranging in size from that of a human hair to dimensions comparable to a person. This precision is crucial for high-performance optics and biomedical applications. Second, the technology facilitates the production of glass with a low reflection index, essential for optical components in smartphones and cameras. Third, it allows for the fabrication of glass in any conceivable shape, mirroring the versatility of traditional 3D printing. Finally, the process is remarkably energy-efficient, saving up to 80% of the energy compared to conventional glass manufacturing methods, making it an eco-friendly alternative for a sustainable future.

Identifying potential opportunities

After grasping these critical aspects, we embarked on comprehensive research. It was essential to familiarize ourselves with the key terms and processes involved in glass production. Simultaneously, we began exploring the various fields where glass is used or could be beneficial. Given that our technology allows us to shape glass similarly to a polymer, the applications of polymers became equally significant to our study. In addition to our research, we also leveraged ChatGPT, which enabled us to broaden the scope of our investigation.

Writing down the features of Glassomer and linking these features to the fields of applications, let us see clearly the benefits of our technology.



Following this comprehensive approach and a very informative week at CERN (see below), we identified five primary fields where Glassomer technology could offer substantial advantages.

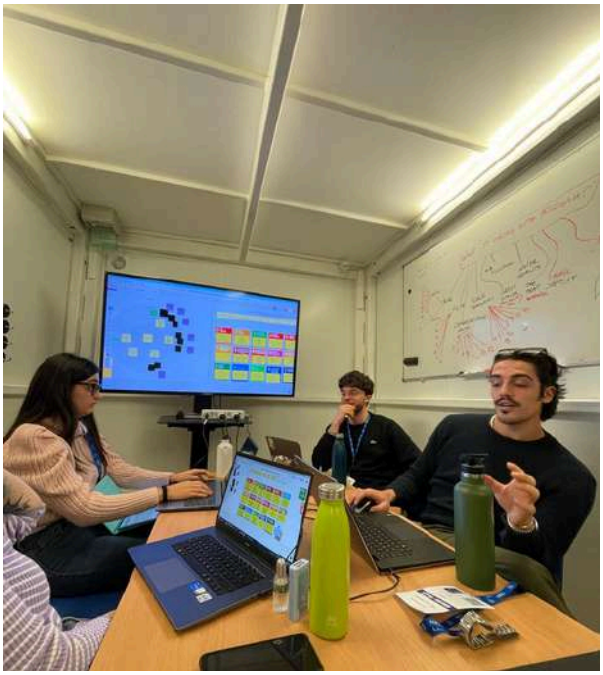
CERN Week

The team's week-long trip to CERN in Geneva, Switzerland, from March 10th to 16th, was a transformative experience that deeply influenced our project's trajectory. Being together non-stop for seven days was more than just a trip—it was a crucial phase in our team formation. We had the opportunity to immerse ourselves in each other's company, learning not just about our professional skills but also about our personalities and work habits. This bonding time was essential as it created a solid foundation of trust and understanding among us, which proved invaluable as we tackled the challenges ahead.

Our visit to CERN couldn't have come at a better time, aligning perfectly with the discovery phase of our project. During this phase, we were still in the process of grasping the technology we were working with and exploring its potential applications. The activities and exercises organized at CERN were eye-opening and thought-provoking. One notable task was devising a method to remove all microplastics from an area the size of Sicily within 1.5 hours. This pushed us to quickly understand, quantify, and brainstorm implementable solutions under tight time constraints. This exercise pushed us to think creatively and collaboratively, marking a pivotal moment where we began to function cohesively as a team. We divided responsibilities while maintaining constant communication and support for one another, which set a precedent for our teamwork moving forward.

We also engaged in exercises to gauge the magnitude and necessity of problems. One such exercise was the **"Nose-rubbing"** activity, which underscored the importance of appropriate problem-solving approaches, such as avoiding over-engineering solutions (e.g., not using a bazooka to kill a mosquito). Another exercise involved evaluating the values of a public toilet and then reversing them. This helped us recognize the often-overlooked values of everyday objects and understand the comparative advantages of our technology.

The **"Mr. Machiavelli"** exercise encouraged us to think critically about the ethical implications and ambitious possibilities of the technology. We had created a movie with our director, Christian, highlighting our technology's functions and values. This exercise deepened our understanding as we had to creatively apply our technology in new contexts. Another significant exercise was the "Six Hats" method, where we were forced to consider problems from multiple perspectives—positive, negative, emotional, objective, and creative. This broadened our approach to problem-solving and fostered a more holistic view.



Additionally, we had in-depth discussions on the United Nations' 17 Sustainable Development Goals (SDGs). These discussions helped us align our technology with global challenges, paving the way for future implementable solutions.

Exploring the CERN facility and engaging with people from IdeaSquare like Ole, and later on with scientists and engineers was equally enlightening. Interacting with experts who push the boundaries of scientific knowledge daily inspired us to aim higher and think innovatively. These interactions reinforced our belief that there are limitless possibilities in scientific research and technology, further motivating us to explore unconventional ideas and solutions.

During the week we had also met our assigned researcher which was crucial; he provided us with firsthand insights into the technology's workings, its capabilities, and its limitations. This knowledge was pivotal as it guided our strategic planning and informed our decision-making process moving forward.

Overall, our week at CERN was not just an educational journey but a profoundly inspiring and motivating experience. It solidified our team dynamics, broadened our perspectives on technology and innovation, and set us on a path of ambitious exploration and discovery. This visit was instrumental in shaping the direction and scope of our project, ensuring that we approached our work with clarity, purpose, and a sense of limitless potential.

By the end of the week, we had identified five distinct areas where our project could make a significant impact: energy, medical applications, design & architecture, laboratory equipment, sound engineering. Each area was thoroughly researched, laying a robust foundation for our future development phases.

Top 5 Fields Selection

MEDICAL FIELD

Glassomer revolutionizes the medical field by providing patients with new solutions for treatments and simplifying procedures for doctors. It aims to advance healthcare by offering precise and efficient tools that can improve patient outcomes and streamline complex procedures.

SDGs: III & X

CHALLENGES

Accessibility: High-costs barrier makes tools inaccessible.

Environmental Impact: Extensive manufacturing processes lead to significant carbon emissions.

Quality Concerns: Inadequate equipment quality can result in misdiagnosis and other critical errors.

OPPORTUNITIES

Accessible Tools: Develop cheaper tools that are accessible to a broader population.

Sustainable Solutions: Create greener, recyclable, and reusable, tools reducing environmental impact.

High-Quality Equipment: Produce tools with superior optical properties, enhancing accuracy and reliability.

LABORATORY EQUIPMENT

Glassomer produces precise and sustainable laboratory equipment, aiding scientists in reducing the use of disposable plastics and minimizing errors. **SDGs: XII**

OPPORTUNITIES

Sustainable Lab Tools: Replace disposable lab plastic with Glassomer-produced glass, which is manufactured in a cost-effective, environmentally friendly manner.

Easy Cleaning: Lab tools with 0 porosity can be cleaned more easily, enhancing lab hygiene and efficiency.

Innovative Tool Design: Develop new lab tools thanks to the free shapeability, allowing customized and advanced designs.

Advanced Applications: Utilize the low reflection index and high silica purity in sophisticated machines like spectrophotometers, improving performance and accuracy.

CHALLENGES

Disposable Plastic Use: The widespread use of disposable plastic in labs contributes to environmental pollution.

Non-Recyclability: Used plastic materials are challenging to recycle, leading to increased waste.

DESIGN & ARCHITECTURE

In the field of design and architecture, Glass2Mass brings innovation to urban infrastructure. It helps improve the quality of life for the general public by creating aesthetically pleasing and functional urban spaces. **SDGs: IX & XI**

CHALLENGES

Unsustainable Production: Current production methods are not environmentally friendly.

High Costs: Advanced building materials are often expensive, limiting their accessibility.

Excessive Use of Plastics: The extensive use of plastic in interior design contributes to environmental degradation.

Public Well-being: There is a need to enhance the psychological well-being of citizens through better-designed urban spaces.

OPPORTUNITIES

Sustainable and Efficient Buildings

Cost Reduction: More affordable advanced technology glass.

Enhanced Well-being: Increase the psychological well-being of citizens through improved urban design.

SOUND ENGINEERING

Glass2Mass improves sound transmission and design in sound engineering. This technology aids professional and commercial users by providing high-fidelity sound with unique designs, enhancing the audio experience. **SDGs: III & IX**

OPPORTUNITIES

Enhanced Acoustic Properties: Improving the sound properties of glass speakers through precision shaping and complex geometries.

Sustainable Market Entry: Introduce greener products, saving up to 80% of production energy.

Reduced E-Waste: Lower electronic waste by replacing traditional hardware with Glassomer.

CHALLENGES

Trade-off in Sustainability: Balancing the increasing need for recyclable products with the principles of a cyclical economy.

Cost of Disposal: Both plastic and wood are cheaper to produce, but they are costly to dispose of and have a significant environmental impact.

Accessibility of Glass: Traditional glass is expensive and often inaccessible for various applications.

ENERGY

Glassomer technology enhances energy production and storage solutions. By creating efficient energy products, it helps reduce the use of polluting materials and improve waste management. **SDGs: VII & XII**

CHALLENGES

Infrastructure: Current energy infrastructure is often inefficient and environmentally damaging.

Energy Storage: Existing energy storage solutions rely heavily on polluting materials.

Technology Efficiency: There is a need to improve the efficiency of current technologies.

OPPORTUNITIES

Replacing Polluting Materials: Substitute polluting materials in the energy storage field with more sustainable alternatives.

Enhanced Efficiency: Improve the efficiency of existing technologies by leveraging the unique characteristics and shapeability of Glassomer.

Increased Recyclability and Durability: Enhance the recyclability and durability of energy components.

DESIGN

Desirability analysis through interviews and research

After the first milestone, the team faced the challenge of convergence to narrow down the chosen opportunities in order to two, based on feasibility and desirability criteria. The main focus at this stage was validating the potential of each opportunity and assessing the ease of eventual implementation.
During the Design phase, the team explored every possible application field for the technology. This phase emphasized gathering evidence to support each idea.

After the first milestone, the team faced the challenge of convergence to narrow down the chosen opportunities in order to two, based on feasibility and desirability criteria. The main focus at this stage was validating the potential of each opportunity and assessing the ease of eventual implementation. During the Design phase, the team explored every possible application field for the technology. This phase emphasized gathering evidence to support each idea.

The day of the first milestone was crucial to move the first steps towards a more defined path, since there was the possibility to have a brainstorming session with the partner after the presentation. At this specific moment, thanks to Bastian's feedback, we decided to eliminate the medical field because of the necessity to restrict the set of opportunities to better focus on the most promising ones. The medical perspective was really interesting from the scientific point of view and, of course, because it could give us the possibility to have a huge impact on people's quality of life, but the main point was the amount of time needed to obtain that impact. In the medical industry a lot of time is required to study the tools, test them and validate their usability with people, for us it was also important to have a tangible result in a reasonable amount of time, that's why we decided to not investigate further on this opportunity.

Talking with experts of all the remaining fields, we understood that all the identified opportunities could be really impactful. In particular we spoke with some entrepreneurs of the glass industry, like Fulvio Puccioni, founder and CEO of Glass Service Italy, and many professors of manufacturing processes and materials engineering, such as professor Leonardo Orazi from UNIMORE or professor Manuela Galati from PoliTo.
This was in order to have feedback on the feasibility of the ideas in all the fields, understand which were the main advantages of each of them from the structural point of view and which were the weaknesses/aspects to be improved. Related to this aspect, the presence of the tech partner's team was fundamental for the team to gather more precise ideas not only from the material perspective but also from the process one, as it will be explained in the next paragraph.

Furthermore, there were a lot of interviews with field experts, mainly professors from around Italy and the world, that assisted our team to deepen the knowledge about all the possibilities. In order to have fruitful conversations with each of those people, we adopted a general structure of questions, made thanks to the knowledge of members with experience on user interviews.

1 GREETINGS

- Begin by introducing yourself and providing background information about the purpose of the interview;
- Introduce the Glass2Mass technology and the goal of our project;
- Ask permission to record and take notes about the interview for accurate documentation.

2 ICE BREAKER

Get to know who we're talking to by first telling what we know (very short, let them talk) about them

- What is fun and exiting about your research/work?
- Who is your favourite scientist ever and why?
- Remember not to take notes in this part of the interview, it is just an ice breaker (and we are recording)

3 OPEN QUESTIONS

Try to get more familiar with the field they are working with

- What do you consider to be the most significant challenges facing [specific field] today?
- How do you envision the future of [specific field], given recent advancements and emerging technologies?
- What role do you believe [specific field] plays in addressing global issues or societal challenges?

4 GENERAL QUESTIONS

Ask horizontal general questions about our tech

- Is there any hidden not disclosed advantage that you see of using this technology?
- Is there instead any disadvantage that you see?
- As you have understood we have a technology that is able to 'print' glass pieces with very high precision, low costs and very high recyclable potential. Where do you think this technology can be useful? For example, where is companies using hard transparent plastic instead of glass to make something because it is cheaper?
- Do you know any start-ups that are currently using a similar technology or making glass products in small dimensions?

5 SPECIFIC QUESTIONS

Define according to expert

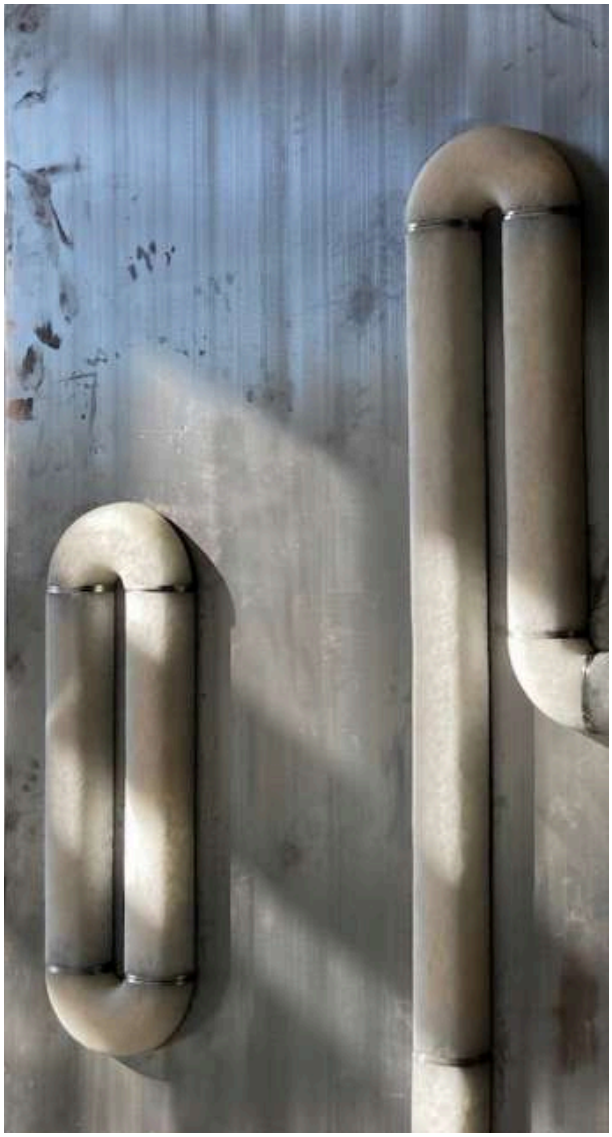
6 CONCLUSIONS

- Do you have any question? Or would you like to add something that we have not asked you?
- What is the next person we need to talk to in order reach our goal? Can you help us contact her/him?
- What is one piece of advice you feel like giving us?

As previously mentioned, all the possibilities turned out to be interesting and valuable.

DESIGN & ARCHITECTURE

From urban furniture to design objects, it was the one that offered the widest range of opportunities and so the biggest freedom of choice. Speaking with professor D'Alessandro, architecture professor from Bologna, the urbanist Milan Milivojevic from Serbia and also additive manufacturing experts was fundamental to recognize, among all the solutions, the most desirable and feasible ones. For example, we talked about the idea of modularity in urban furniture, such as modular street lamps and passive lighting in public spaces. The ideas were leveraging the freedom of design and the logistics, but finally we realized that there was a significant problem in safety and resistance of the material in public spaces. As a conclusion, we realized the most promising and fascinating aspect of the design field was the possibility of redirecting light by creating patterns in design objects, that has no feasibility issues due to size and cost limitations or safety for public spaces.



SOUND ENGINEERING

Experts the team has talked to agree that from the outset, ideas in this field have been a perfect blend of feasibility, marketability, and scientific advancement. Interviews conducted by the team with sound engineer Mehmet Çolak, telecommunications professor Fabrizio Pancaldi, and sound engineering expert Emilio Lorenzani from UNIMORE revealed that creating speakers made almost entirely of glass is an intriguing concept. However, there are concerns about the efficiency-cost ratio. Since typical materials used for speakers are polymers, wood, or ceramics, the increased cost of using glass must be justified by a corresponding improvement in efficiency and sound quality.

It was also found that speakers partially made out of glass are produced, and y companies such as Sony, but the idea was making a speaker entirely made out of glass.

LAB EQUIPMENT

This field is likely the most impactful for reducing plastic waste, particularly given the significant waste generated by disposable cuvettes. In an interview with Doctor Ferda Aydın Baydar in Turkey, we identified several key points. First, there is a significant opportunity to reduce costs associated with durable cuvettes by manufacturing them in a more sustainable manner. This could involve using more eco-friendly materials and adopting processes like injection molding to enable mass production, thereby driving down costs through economies of scale.

However, a critical concern is whether using Glass2Mass instead of traditional glass would compromise the material's main strengths and, most importantly, hinder the potential for innovation.

ENERGY

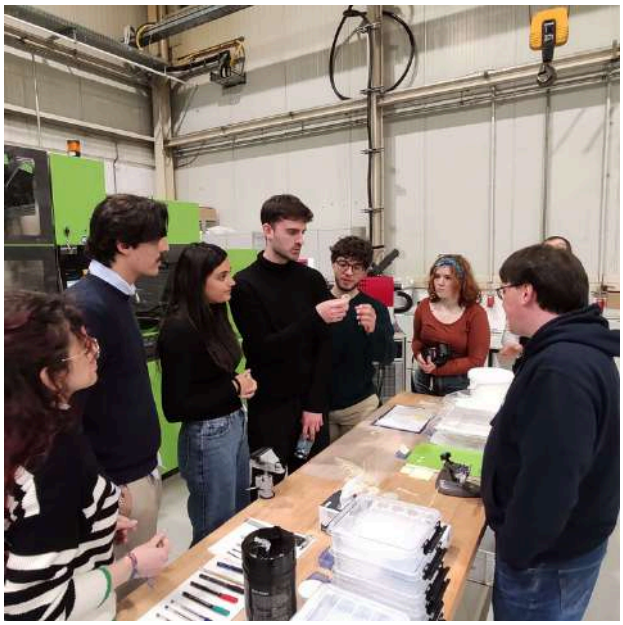
From an experimental perspective, one of the most exciting areas involves the energy production and storage field. Professors Luca Montorsi and Monia Montorsi from UNIMORE expressed keen interest in the potential of creating solid-state batteries with electrolytes and cathodes made of glass, as well as thermal solar panels with variable shapes. Both ideas are stimulating and challenging, as glass is a greener alternative to the polluting materials currently in use and holds promise for efficiency and storage capacity.

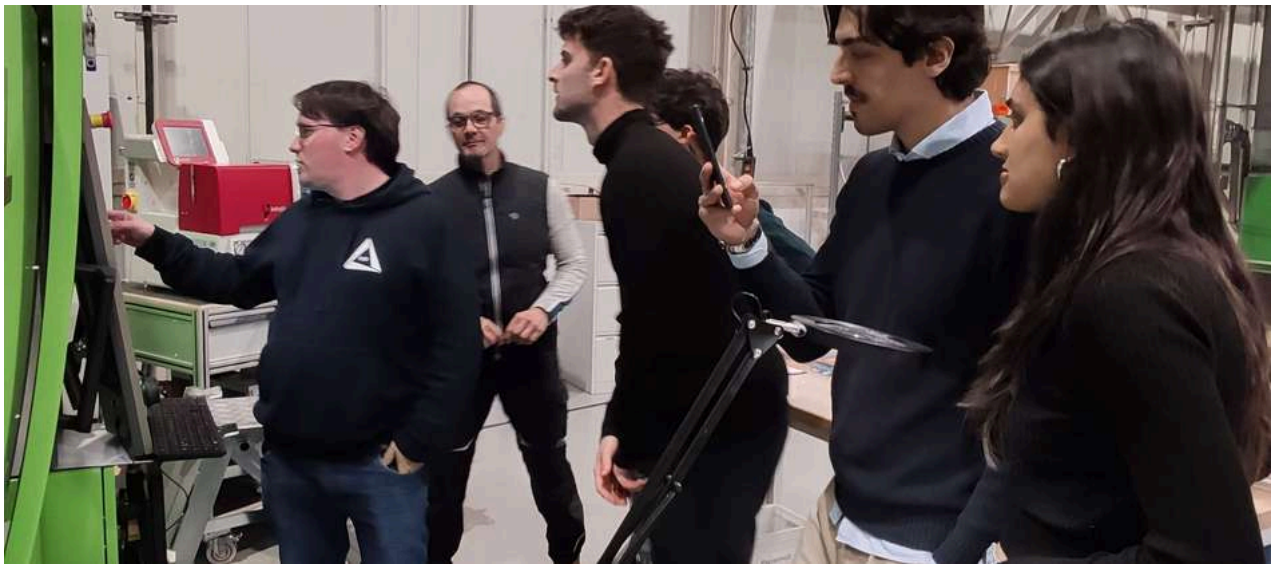
The critical aspects identified include:

1. Studies on efficiency would be very time-consuming and might not guarantee conclusive results.
2. Glass is not naturally conductive, posing a challenge to enhance its conductivity for batteries by incorporating other materials, while ensuring it works efficiently and maintains a reasonable cost-efficiency ratio.
3. Both applications would compromise some of the main advantages of glass, such as its purity, high transparency, and the ability to create complex shapes.

Freiburg Glassomer Mobility

During the third week of April, the team visited their tech partner in Freiburg, Germany. All the team members, except Manuel (he took a Flixbus), made the trip in Edoardo's car. We left on the morning of April 14th and arrived in Freiburg in the evening of the same day. The stay lasted from the 14th to the 17th, with a visit to the tech partner's facility planned for the 16th. During the first two days, we had the chance to visit the city and work on our ideas additionally in order to show Bastian and other Glassomer members our progress and ideas for various technology applications.
On the morning of the 16th, we met Eleonora, and together we went to the Glassomer facility. There, the CEOs of the company showed us the potential of the technology and the production process. Visiting the facilities and seeing all the machines, raw materials and processes from beginning to end, we understood the uniqueness of Glass2Mass technology and how fast and green the whole process is.





Moreover, seeing the results od 3d printing and products that were made was very impressive as the objects were of very small dimensions while retaining detail and precision. The interaction with Frederich was very useful; after we showed him our ideas, he was enthusiastic about the sound engineering application. He also suggested thinking about possible applications in audio playing systems or musical instruments.

After a long review session with Bastian, who gave us valuable advice about the feasibility of our ideas, the team had a brief discussion about their emotions. All of us were a little uncertain about the next steps, but thanks to Eleonora, we understood that the next phase was designed to lead us on the right path. After that, we had lunch together and spent our last day exploring the city. On the morning of the 17th, everyone left, Manuel by Flixbus and the other members by Edoardo's car. We were all satisfied with the trip and the visit, we enjoyed the time spent together, and we returned even more bonded.

Selecting the priority field based on evidence and feedback collection

Before the visit to the tech partner facility, the team returned to work at Almalabor to select the most interesting fields from the five possible alternatives. Since we couldn't focus on all five, we decided to vote on which ones deserved further investigation. We created a ranking based on characteristics that were important to us:

- Impact on society
- Feasibility
- Personal preference
- Time to market

After the voting, the top three fields were Lab Equipment, Architecture, and Sound Engineering. We then divided the workload as follows: Sonja and Christian on Architecture, Edoardo and Eloisa on Sound Engineering, and Manuel and Irem on Lab Equipment. The most interesting findings from the research were:

ACHITECTURE & DESIGN

We explored the possibility of using Glass2Mass to create a modular light system or to construct solar tubes. A solar tube is a structure that transmits or distributes natural or artificial light for illumination, serving as an example of optical waveguides. It consists of a dome installed on the rooftop, a reflective tube that goes inside the building, and a diffuser to spread the light within the apartment. Our idea was to replace the dome and diffuser, both currently made of polyacrylate, with pure silica glass using our technology. This change would maximize sunlight penetration and make the components fully recyclable.

SOUND ENGINEERING

Use Glass2Mass to improve the sound performance of audio player systems. The idea originated from research conducted by Edoardo and Eloisa, who found tests performed by a Japanese company on glass diaphragms. According to the research, these glass diaphragms improved sound quality by 25 to 30%. Our initial idea is to use this technology to build high-performance speakers.

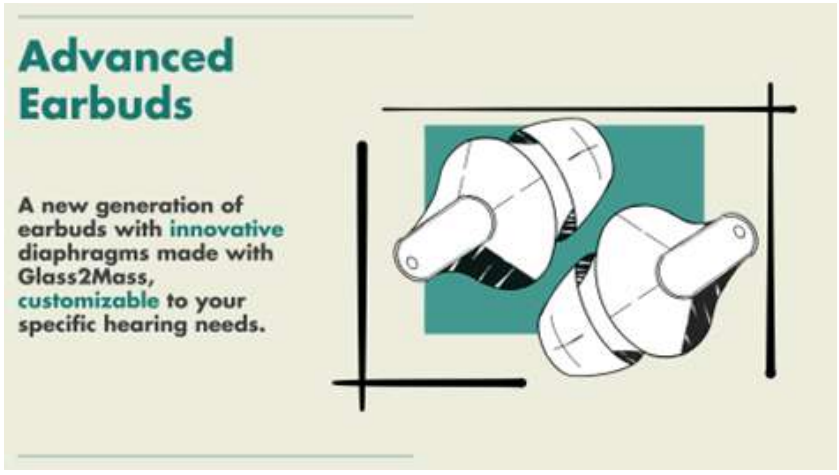
LABORATORY EQUIPMENT

The lab equipment field was still under discussion. Our original idea was to use Glass2Mass to replace cuvettes in pharmaceutical labs, so we contacted some experts. They were unsure about the real impact of the technology in this field. According to them, plastic is still widely used in labs, and the existing glass cuvettes are already 100% reusable.

After our time in Freiburg, we reanalyzed our options. According to Bastian's advice, all the ideas were technically valid; we could use Glass2Mass technology to create a new dome and diffuser for solar tubes, as well as to replace existing cuvettes in labs. Feeling that three paths were too many, we decided to base our decision on time to market and economic sustainability. After brainstorming, we chose to eliminate the field we deemed less impactful: lab equipment. We selected the solar tube idea as the primary focus for the architecture field.

Regarding sound engineering, we still had alternatives. While using Glass2Mass to create a high-quality diaphragm for a new device seemed promising, we postponed a definitive choice until the next phase. During the Rehearsal pre-2nd Milestone, Prof. Mincolelli expressed doubts about creating a pure silica glass diaphragm for speakers due to concerns about its elastic properties for such large devices. This echoed concerns raised by sound engineering experts during our interviews. Prof. Vignoli suggested investigating the possibility of using the diaphragm in earbuds instead. He liked the idea of allowing users to customize their diaphragms to enhance their music listening experience based on their individual hearing needs.

Our brief research revealed that adjusting the thickness and circumference of the diaphragm could not only improve music quality based on hearing needs but also enhance external sound perception using microphones in the earbuds. We identified an intriguing niche between earbuds and hearing aids that few, aside from a single company (Vitha), were exploring. This led us to the 2nd Milestone with two focused fields and ideas: changing the dome and diffuser in solar tubes for architecture and developing a new device bridging high-quality earbuds and acoustic aids for sound engineering.



DEVELOP

Discovering the possibilities and limits of our idea through interviews

At the outset of our project, our team faced the challenging yet exciting task of selecting an idea that we believed held the most promise and interest. We debated three innovative concepts: solar tubes, glass cuvettes for lab equipment, and new-generation earbuds as hearing aids. After extensive discussions and evaluations of each idea's potential impact, feasibility, and personal intrigue, we collectively decided that the concept of multi-functional earbuds was the most compelling. This choice was driven by the following considerations:

SOLAR TUBES

Pros:

- Environmentally friendly technology.
- Potential to reduce energy costs and reliance on non-renewable resources.
- Could contribute to sustainability efforts and green energy solutions.

Cons:

- High initial cost of implementation and infrastructure.
- Potential limitations in regions with low sunlight.
- Long-term maintenance and efficiency concerns.

PRETOTYPES

GLASS CUVETTES FOR LAB EQUIPMENT

Pros:
- Essential for scientific research and development.
- Possibility to innovate with new materials or designs.
- Steady demand in academic and commercial laboratories.

Cons:
- Niche market with limited scalability.
- High competition from established manufacturers.
- Incremental innovation with limited breakthrough potential..

NEW GENERATION EARBUDS AS HEARING AIDS

Pros:
- Dual functionality appeals to a broad consumer base.
- High potential for improving the quality of life for people with hearing impairments.
- Growing market with advancements in wearable technology and healthcare.

Cons:
- Regulatory hurdles in the healthcare sector.
- High expectations for performance and reliability.
- Technical challenges in integrating advanced hearing aid technology into compact earbuds.

Final decision of the Idea and explanation

Our interest gravitated towards the new-generation earbuds primarily due to their dual functionality and the potential to significantly enhance everyday life for users. We envisioned a product that not only serves as a high-quality audio device but also discreetly provides hearing aid functionality, addressing a critical need with style and convenience.

This product is a revolutionary innovation that combines the functionalities and design of earphones with the concept of custom-made hearing aids. Leveraging on Glass2Mass technology it is possible, thanks to the properties of pure silica glass and the innovative processes used for the manufacturing, to meet the specific hearing needs of each customer.

Exploring the Idea Through Interviews

To further understand the viability and limitations of our idea, we conducted interviews with various stakeholders, including potential users like audiologists, such as Doriano Peviani from Acustica Biellese. These interviews provided invaluable insights into both the possibilities and constraints of our concept.

Key Insights from Interviews

01 — User interest and Acceptance

Many potential users expressed enthusiasm for the idea of earbuds that also function as hearing aids. They appreciated the discretion and convenience of a device that does not look like a traditional hearing aid, reducing the stigma often associated with hearing impairment.

02 — Technological Feasibility

Our tech partner Bastian highlighted the rapid advancements in miniaturization of Glass2Mass technology for the manufacturing of the diaphragms that make our idea feasible. However, they also pointed out significant challenges in ensuring reliable performance and battery life, especially given the dual functionality.

03 — Customising Concerns

Audiologists emphasized the rigorous testing required for hearing aids, and suggest to focus more on providing sufficient customization to cater every hearing needs

04 — Market Potential

Industry professionals identified a strong market potential for such a product, particularly among younger users and tech-savvy individuals who are more likely to adopt new technology. However, they also cautioned about the competitive landscape and the need for significant marketing efforts to establish trust and brand recognition.

CONCLUSION

The interviews provided invaluable insights into both the possibilities and limits of developing new-generation earbuds as hearing aids. We discovered that while there is significant interest and potential for such a product, we must navigate complex technical challenges. The feedback also highlighted the importance of user-centric design and rigorous testing to ensure our product meets the needs of both hearing-impaired and general users.

In conclusion, our decision to explore advanced earbuds as hearing aids has opened up a promising avenue for innovation. By addressing the challenges and leveraging the insights gained from our interviews, we are poised to create a product that not only enhances audio experiences but also improves the quality of life for those with hearing impairments.

Creating a Business Plan

Creating our business plan was a meticulously crafted process that evolved continuously throughout the final development phase. This phase was critical as it allowed us to refine and reshape our strategy in response to emerging insights and market dynamics. We adopted an iterative approach, updating our plan as our concept matured and as we gained deeper insights into the technological feasibility and market potential of our product. Central to our planning process was the use of tools like the ethics canvas, ensuring that our business model aligned with ethical principles and societal values throughout every decision-making step.

Our business canvas provided a comprehensive framework for understanding and articulating the key components of our business strategy. Below, you can find the ethics canvas that we utilized. The business model canvas will be elaborated upon in detail in the following paragraph.

<table>
<tr>
<td rowspan="2">INDIVIDUALS AFFECTED
-People with hearing problems
-Lovers of music
-Musicians
-Workers finding themselves in loud workplaces
-Lower class people</td>
<td>BEHAVIOUR
-Improves the quality of life
-Increases the gap between social layers</td>
<td rowspan="2">WHAT CAN WE DO?
-Try to make the product more accessible over time
-The social injustices</td>
<td>WORLD VIEWS
Perceiving music as customizable
Relevant research speed up
People see themselves as a more included part of society</td>
<td rowspan="2">GROUPS AFFECTED
-Hearing aid companies
-Sound production companies
-Headphone companies
-Doctors associations</td>
</tr>
<tr>
<td>RELATIONS
New
-Hearing aid companies and sound companies
-People with hearing problems and hearing test centres
Eliminating
-Hearing aid companies and people with hearing problems</td>
<td>GROUP CONFLICTS
-Competition between companies
Some workers could lose their job
-Decreasing the work load of membrane producers therefore affecting jobs
-It is discriminating between social classes excluding people with a lower buying power</td>
</tr>
<tr>
<td colspan="2">MALFUNCTIONS
-If people use wrong configuration it can be damaging to their hearing
-It can be used for military purposes as a communication device between units
-People could fake their test in order to buy a wrong configuration
-Due to human error the shaping can be wrong therefore causing possible perforation in the ear</td>
<td colspan="3">ENVIRONMENT & RESOURCES
-Combining the glass2mass and polymers therefore a high and low-impact production it would still be effectful on the environment
-It reduces the plastic use but not with a high stamp</td>
</tr>
</table>

1 KEY PARTNERS

We identified key partners essential to our success, including Glassomer, our technological collaborator responsible for the advanced glass membrane technology that forms the core of our product. Additionally, partnering with acoustic centers allowed us to offer a complete service package to customers, including initial hearing tests and customized outer ear shell molding. These partnerships were integral to delivering a seamless and high-quality customer experience from diagnosis to product use

2 KEY ACTIVITIES

Key activities outlined in our business plan encompassed a range of operational tasks essential to product development and customer service. This included everything from the assembly of our innovative earbuds to the manufacturing of the specialized glass membrane. Our commitment to ongoing customer service and the reinforcement of strategic partnerships were also highlighted as critical activities aimed at maintaining customer satisfaction and enhancing our market position.

3 KEY RESOURCES

In terms of key resources, we identified and allocated the necessary physical, human, and intellectual resources needed to support our operations and drive innovation. This included securing office spaces for administrative tasks and product development, investing in state-of-the-art injection molding and 3D printing equipment for manufacturing, and building a team of skilled professionals with expertise in technology, customer service, and business development. Intellectual capital, including proprietary knowledge of the technology and software development capabilities, was also recognized as a key resource supporting our competitive advantage in the marketplace.

4 COST STRUCTURE

Our cost structure was carefully planned to account for the various expenses associated with running our business. This encompassed predictable costs such as office rent, website development and maintenance, salaries for our talented team, marketing expenditures to promote brand awareness and drive sales, ongoing software development to enhance product features, procurement of high-quality materials including the glass membrane, utilities to support operational needs, and packaging costs to ensure product safety and appeal.

5 VALUE PROPOSITION

A cornerstone of our business strategy was our unique value propositions aimed at addressing the specific needs and preferences of our target customers. These propositions included the ability to customize earphones to fit individual ear shapes and preferences, ensuring superior sound quality that enhances both everyday listening experiences and special occasions such as concerts or sporting events. Additionally, our commitment to adapting software according to customer feedback and evolving technological advancements underscored our dedication to continuous improvement and customer satisfaction.

6 CUSTOMER SEGMENTS

The customer segments defined corresponded with people suffering from mild hearing impairments not wanting to buy a hearing aid while searching for a functional solution. They might not want to buy a hearing aid due to stigma associated with the device or high costs. Other customer segment identified are audiophiles passionate about high-fidelity sound, and enthusiasts looking to enhance their entertainment experiences. These individuals are expected to be more price tolerant due to their passion and search for high-quality music.

7 CUSTOMER RELATIONSHIPS

Our cost structure was carefully planned to account for the various expenses associated with running our business. This encompassed predictable costs such as office rent, website development and maintenance, salaries for our talented team, marketing expenditures to promote brand awareness and drive sales, ongoing software development to enhance product features, procurement of high-quality materials including the glass membrane, utilities to support operational needs, and packaging costs to ensure product safety and appeal.

8 CHANNELS

To effectively reach and engage our diverse customer segments, we devised a multi-faceted channel strategy. This strategy encompassed leveraging social media platforms to build brand awareness and engage with potential customers, maintaining an informative and user-friendly website as a central hub for product information and customer interactions, facilitating direct communication channels such as email and customer service hotlines, and offering personalized customer profiles to enhance the shopping experience and support ongoing customer relationships.

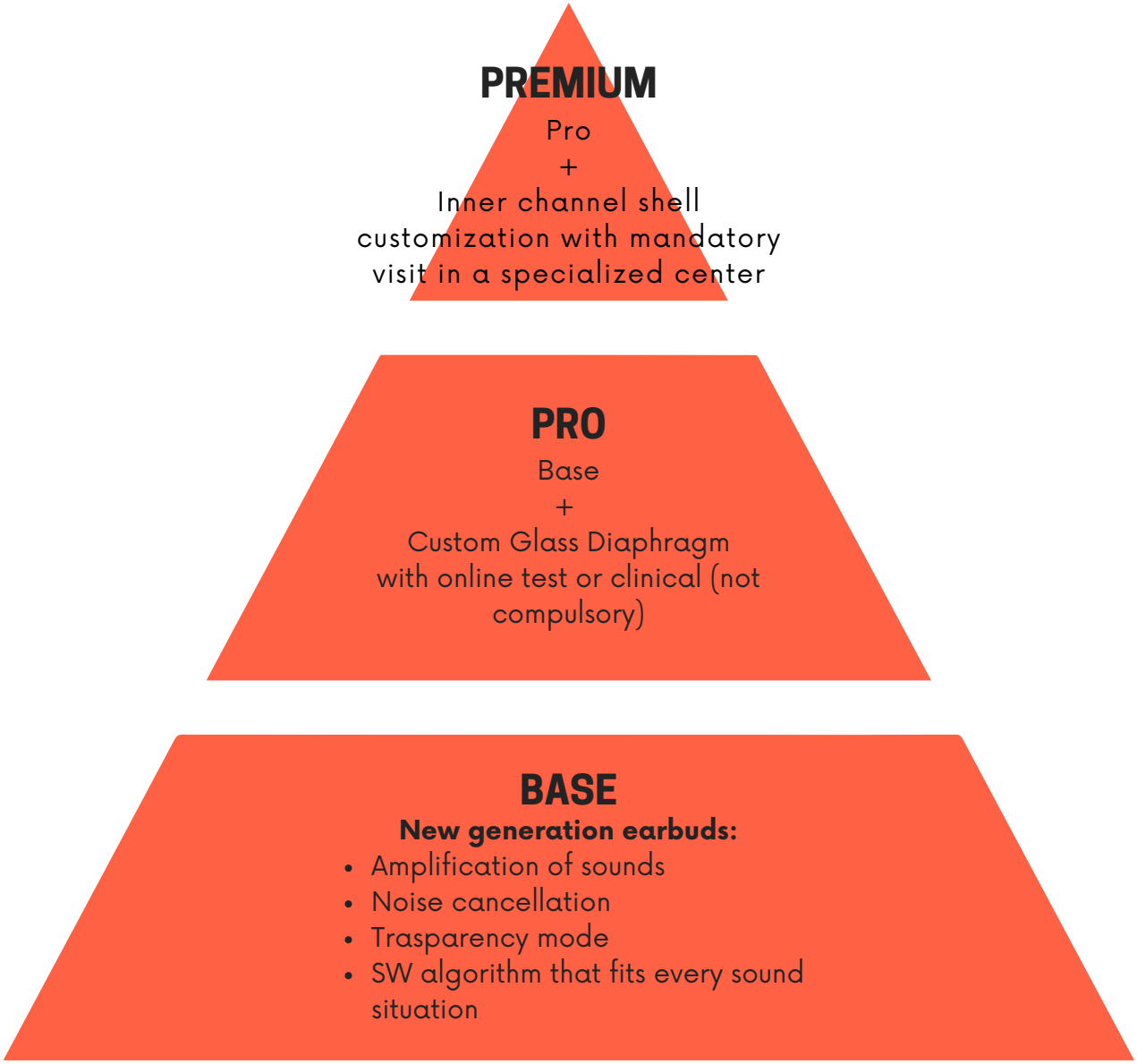
9 REVENUE STREAMS

Finally, our revenue streams were diversified to capture value from various sources. Primary revenue sources included direct sales of our innovative earbuds, which catered to both individual consumers and corporate clients seeking bulk purchases for employee welfare programs or promotional activities. Additionally, we planned to introduce subscription-based models offering access to advanced software features that enhance the functionality and customization options of our earbuds. Finally, revenue would also be generated through periodic replacement sales of essential components such as the glass membrane and other wearable accessories, ensuring ongoing customer engagement and revenue sustainability.

In conclusion, our comprehensive business plan provided a strategic roadmap for launching and scaling our innovative earbuds that double as hearing aids with a glass membrane. By leveraging strategic partnerships, innovative technologies, and a customer-centric approach, we aimed to address market needs effectively while maintaining ethical standards and ensuring sustainable growth. This detailed planning process positioned us to enter the market with confidence, poised for success in delivering transformative solutions to individuals with mild hearing impairments and enthusiasts seeking enhanced auditory experiences.

Service Design Plan

Our service offerings are designed to cater to a wide range of auditory needs, from general high-fidelity audio to fully customized solutions for individuals with specific hearing requirements. Below, you can find the service design plan for the three levels of service we provide: Basic, Pro, and Premium. In the following paragraph, each of the levels will be explained in greater detail.



I LEVEL - BASIC

Description: The URBUD Basic is an earbud equipped with a pure silica glass membrane, providing exceptional sound quality suitable for everyday use.

Features: High-fidelity sound, ergonomic design, durable build, and universal fit.

Target Audience: General consumers and/or music enthusiasts seeking high-quality audio without customization.

II LEVEL - PRO

Description: The URBUD Pro offers a moderate level of customization through an online hearing test. Based on the test results, users receive a membrane specifically designed to address their hearing needs.

Features: Personalized membranes with varying thicknesses (6-7 types) to enhance specific frequencies, tailored recommendations based on hearing test results.

Target Audience: Users with specific hearing needs who seek a tailored audio experience.

III LEVEL - PREMIUM

- Description: The URBUD Premium provides the highest level of customization through a collaboration with acoustic centers. Customers receive a 3D ear scan and a custom mold, along with a specially designed membrane to meet their unique auditory requirements.
- Features: 3D ear scanning, custom-molded earbuds, bespoke membranes crafted beyond the standard 6-7 types, comprehensive hearing tests conducted by professionals.
- Target Audience: Audiophiles, musicians, professionals, and individuals with significant hearing needs requiring full customization.

Service Implementation Plan

I - BASIC SERVICE IMPLEMENTATION

- **Product Development:** Manufacture high-quality earbuds with pure silica glass membranes.
- **Packaging:** Design and produce user-friendly packaging including ear tips of various sizes, charging case, USB-C charging cable, and user manual.
- **Website Integration:** Create a dedicated shop page for URBUD Basic with product descriptions, features, benefits, and customer reviews.
- **Sales and Distribution:** Establish sales channels through the URBUD website, e-commerce platforms, and retail partners.

II - PRO SERVICE IMPLEMENTATION

- **Online Hearing Test Development:** Develop an intuitive online hearing test that users can complete to determine their specific hearing profile.
- **Custom Membrane Production:** Create a range of membranes (6-7 types) with different thicknesses to address various hearing frequencies.
- **Website Integration:** Implement the hearing test on the URBUD website, ensuring seamless user experience and integration with the product recommendation engine.
- **Order Fulfilment:** Set up a system for producing and shipping customized membranes based on test results.
- **Partnerships with Acoustic Centers**: Establish collaborations with leading acoustic centers for providing comprehensive hearing tests if selected by the customer.

II - PREMIUM SERVICE IMPLEMENTATION

- **Partnerships with Acoustic Centers:** Establish collaborations with leading acoustic centers for providing 3D ear scans and comprehensive hearing tests.
- **Custom Mold and Membrane Production:** Develop technology for creating custom-molded earbuds and bespoke membranes tailored to individual needs.
- **Appointment Scheduling System:** Integrate a scheduling system on the URBUD website for users to book appointments at nearby acoustic centers.
- **Customer Support:** Provide dedicated customer support to assist users through the process of scheduling, testing, and fitting their custom earbuds.

CUSTOMER SUPPORT

- **Email Support:** Provide timely and efficient email support for customer inquiries.
- **Follow up:** Sending follow up communication messages for feedback and check up for hearing level.

Making a Prototyping Plan

I - OBJECTIVES

Understand the internal components of current generation earbuds and hearing aids.
Design and manufacture diaphragms using Glass2Mass technology.
Test and compare the performance of Glass2Mass diaphragms against traditional plastic ones.
Evaluate the impact of diaphragm diameter and thickness on sound quality.
Test and optimize the shape of the device shells.
Integrate electronic components into redesigned shells and assess overall device performance.
Designing the product webpage for the customization of the products.

II - INITIAL UNDERSTANDING

Disassembly and Analysis

Objective: Gain a comprehensive understanding of the internal components and assembly of current-generation earbuds and hearing aids.

Steps:

- Disassemble multiple models of earbuds and hearing aids.
- Document and analyze each component's function and material.
- Identify key areas for potential improvement, focusing on the diaphragm and shell.

III - DIAPHRAGM DESIGN AND MANUFACTURING

Material Replacement:

Objective: Design and manufacture diaphragms using Glass2Mass technology, replacing the conventional plastic diaphragms to enhance sound quality.

Steps:

- Collaborate with our tech partner specializing in Glass2Mass technology.
- Design diaphragms with varying diameters and thicknesses.
- Manufacture prototypes of Glass2Mass diaphragms.

Comparison Tests:

Objective: Evaluate the performance of Glass2Mass diaphragms against plastic diaphragms.

Method: Conduct sound tests with the electronic hear to analyze how different diameters and thicknesses affect sound quality.

Metrics: Measure sound clarity, frequency response, and overall acoustic performance.

IV - SHELL DESIGN AND USER TESTING

Shape and Size Exploration:

Objective: Determine the optimal shape and size for the earbud shell for enhanced user comfort performance and fit.

Process:

- Design multiple shell prototypes with different sizes and shapes.
- Conduct user testing to gather feedback on comfort and usability.

Selection Criteria: User feedback on comfort, fit, and aesthetic preferences.

Expected Outcome: Identification of the most comfortable and user-friendly shell design.

V - INTEGRATION OF COMPONENTS

Testing New Shell Design:

Objective: Ensure that the new shell design is compatible with the internal components of current-generation earbuds.

Process: Assemble the earbuds using the chosen shell design and test for fit and functionality.

Metrics: Evaluate ease of assembly and disassembly, modularity, component fit, and overall integrity of the design.

Creating and Testing the Prototype Design

After we completed all the preliminary studies, we started to understand how to create the physical prototype. We began with different 3D models made by Christian and Edo in Autodesk Fusion CAD software. The shapes were inspired by various types of earbuds: two more compact designs inspired by JBL earbuds and Beats Studio Buds Pro, and another inspired by Nothing earbuds and Apple AirPods Pro. Once we had all the 3D models, we started the printing process in the Maker space using a 3D resin printer under Max's supervision.

Once we had the first physical prototype, we began with initial personal feedback sharing and wearing tests. We already had our favorite, but we had to validate that with users. The perfect opportunity came during Grenoble week when Eloisa brought all the physical prototypes to show to people, explaining the concept and collecting feedback. After that week, people's favorites were the same as those we chose before (the one inspired by Nothing Earbuds), but they perceived them as too fragile, especially the stem part.

To address this design problem, Christian went back to work on the 3D model. We decided to change the shape slightly and increase the stem dimensions by 1 mm. To give our product a unique look, we also added a small hole at the end of the stem. The final version was ready. We 3D printed it once again, and then we gave it to people.
The first testing phase was with CBI colleagues. They wore our earbuds and conducted comfort tests. They walked around, tried to touch the physical controls, and ran with them on. The prototype passed all the tests; everyone liked them, particularly in terms of shape, but they suggested that we pay attention to the future material of the outer shell.

Then we shared the prototype with external users. Particularly useful was the interaction with Elisa ("Tesoh" as we called her in the final Milestone presentation), a friend of Christian's who suffers from mild hearing problems. She liked the concept and design of the earbuds and also loved the material shown in the preliminary renderings. She said she would wear them regularly in her daily routine.

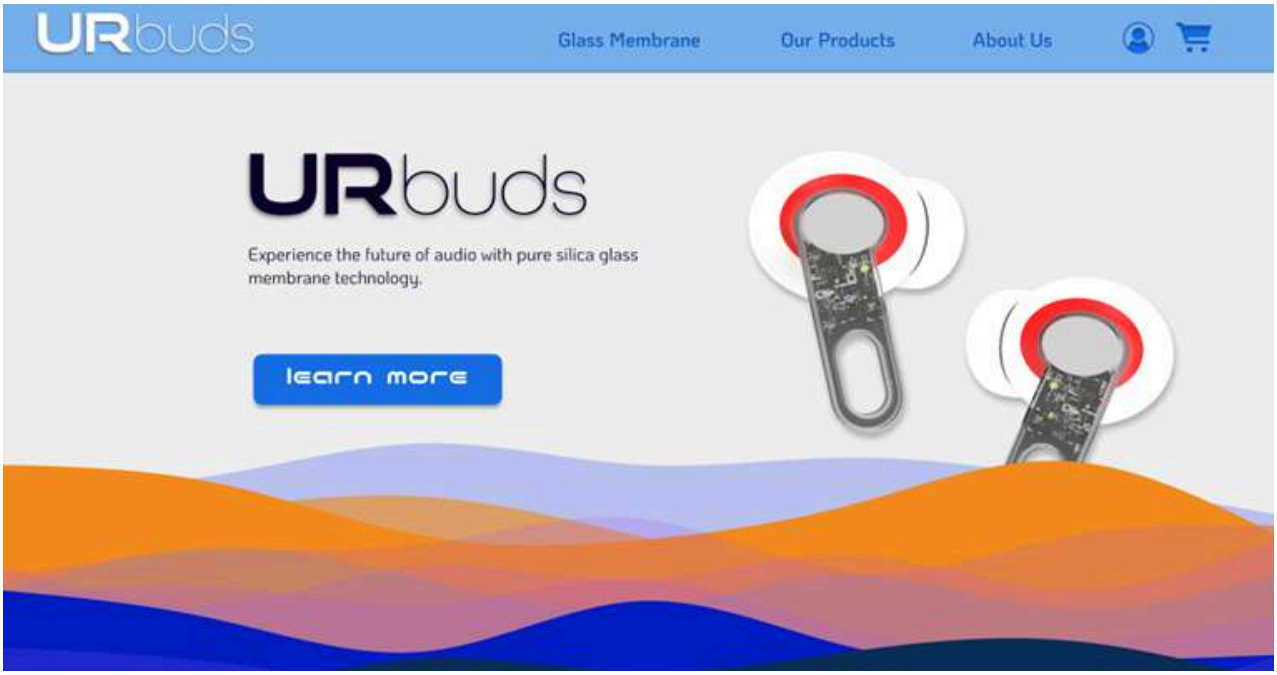
A unique design feature that everyone liked was the hole in the stem. All the users found different and new ways to use it. Once we validated our design, we used acrylic colors to paint them. We had our final version.

Web Page Design

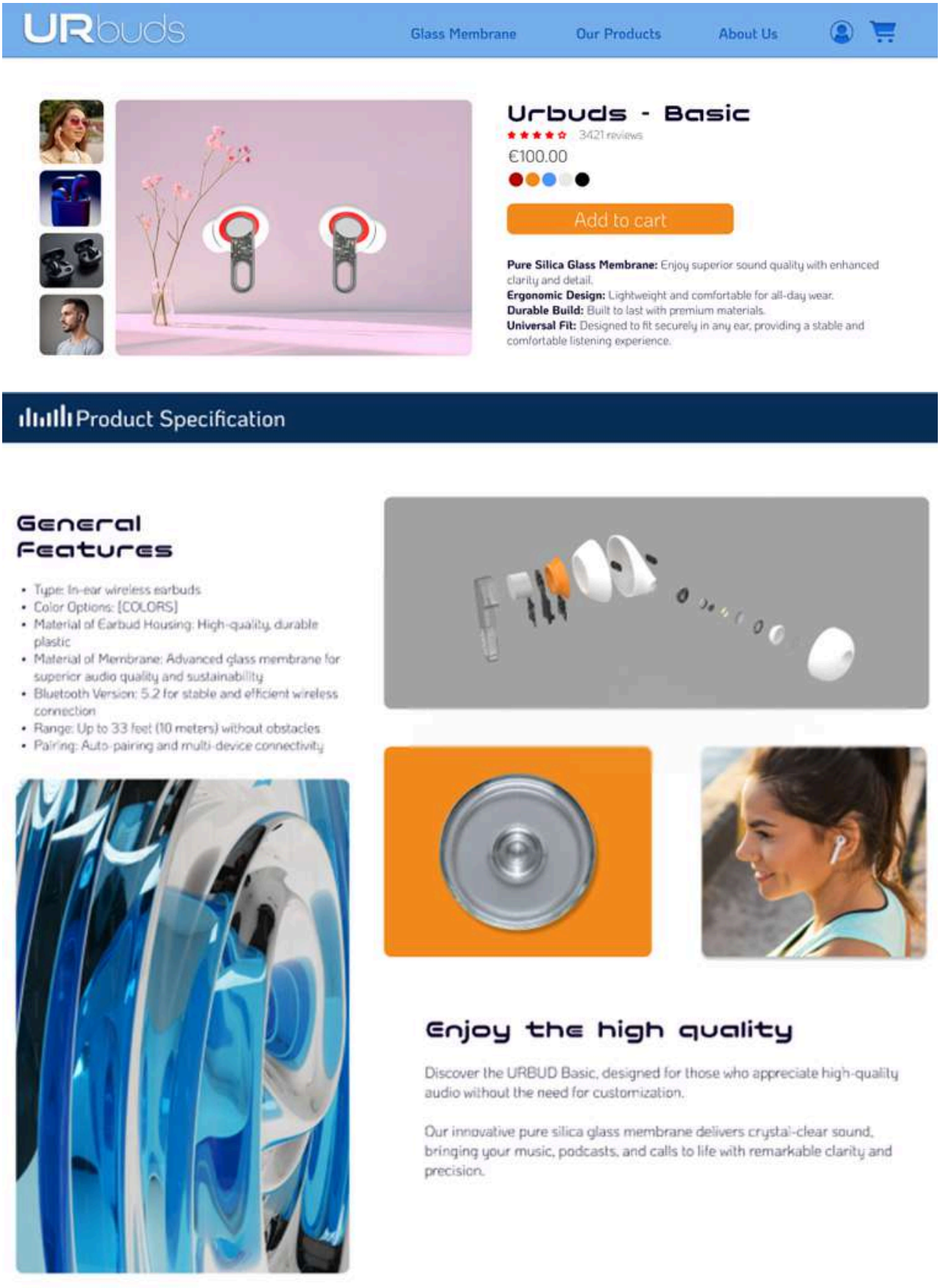
CREATE AND STRUCTURE THE SERVICE OF THE BRAND

1. Define the Page Structure:

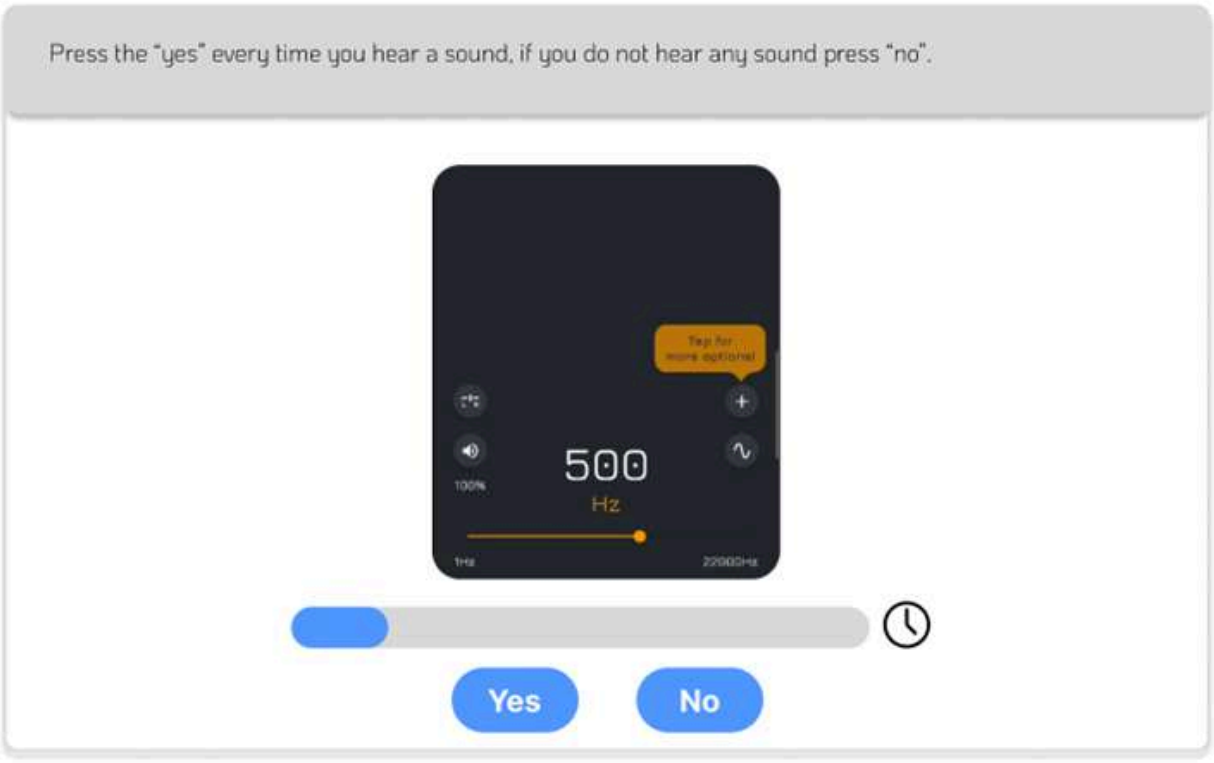
HOME PAGE - LANDING PAGE
Introduce the URbuds brand and showcase the unique features of the BASE, PRO, and PREMIUM earbuds.

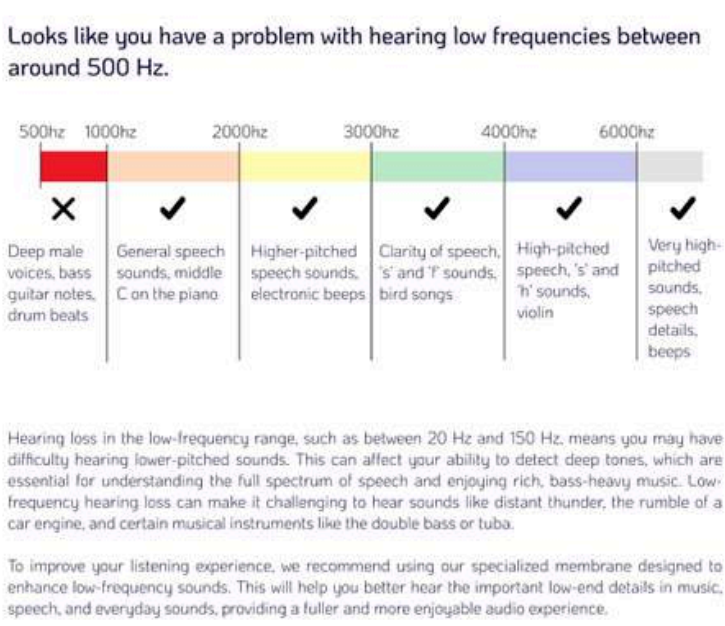


PRODUCT PAGES
Detail the specifications and customization options for each earbud model.



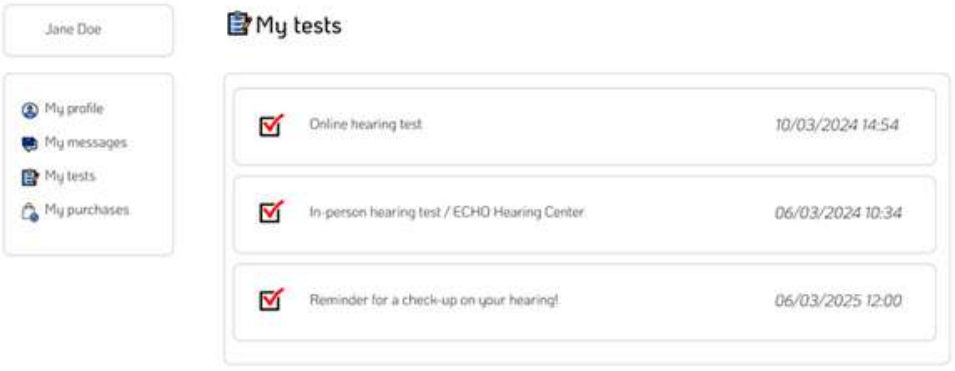
HEARING TEST INTEGRATION
Provide an online hearing test feature, or direct users to our affiliate acoustic centers for in-person testing.

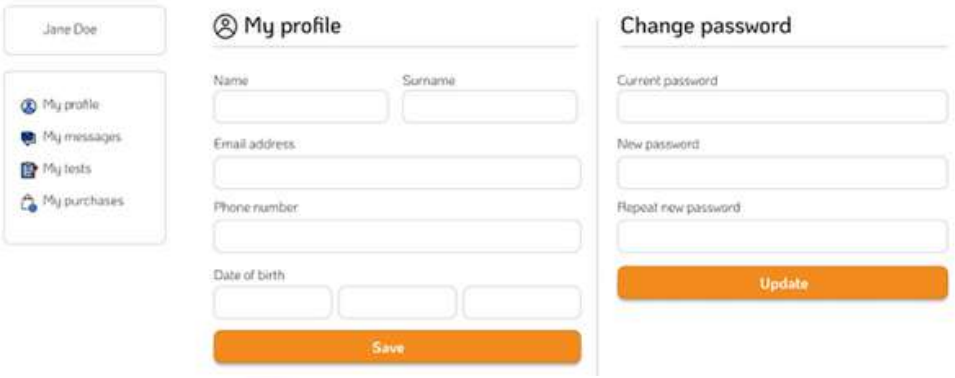


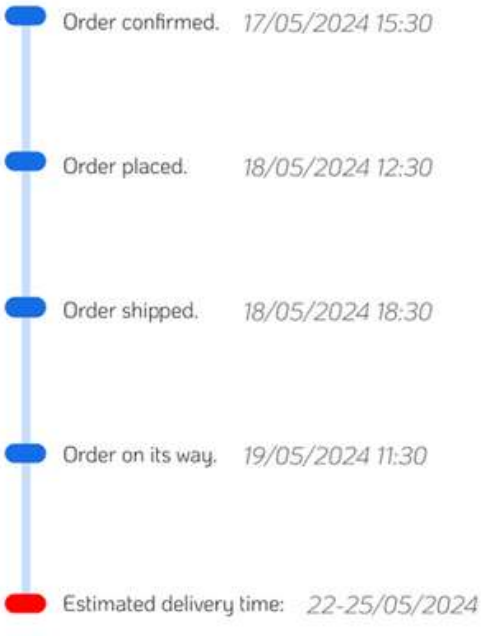


CREATING A CUSTOMER PROFILE PAGE

Objective: Establish a profile page to enable ongoing communication with customers for feedback and future relations such as a check-up for their hearing.
Functionality: Allow customers to create profiles where they can manage their orders, preferences, and provide feedback.
Future Engagement: Use customer profiles for personalized communication, updates on new products, and support services.
Tracking the purchase: Allow the customer to track the situation of their earbud.

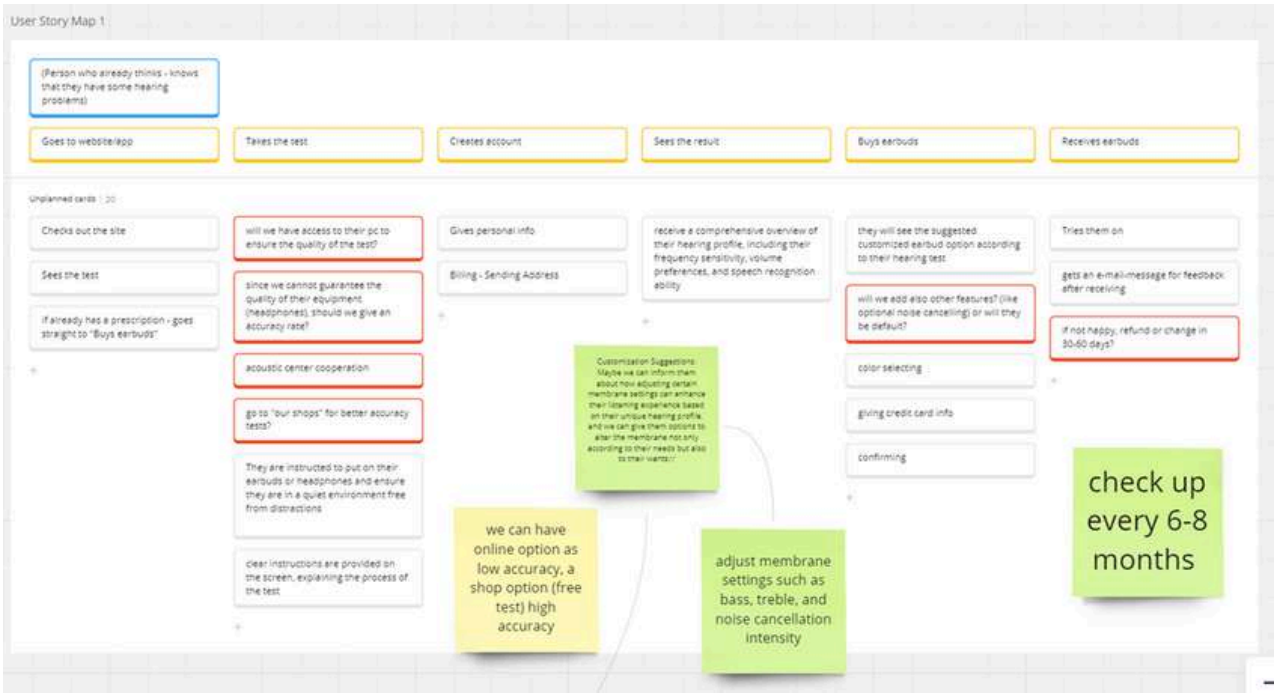


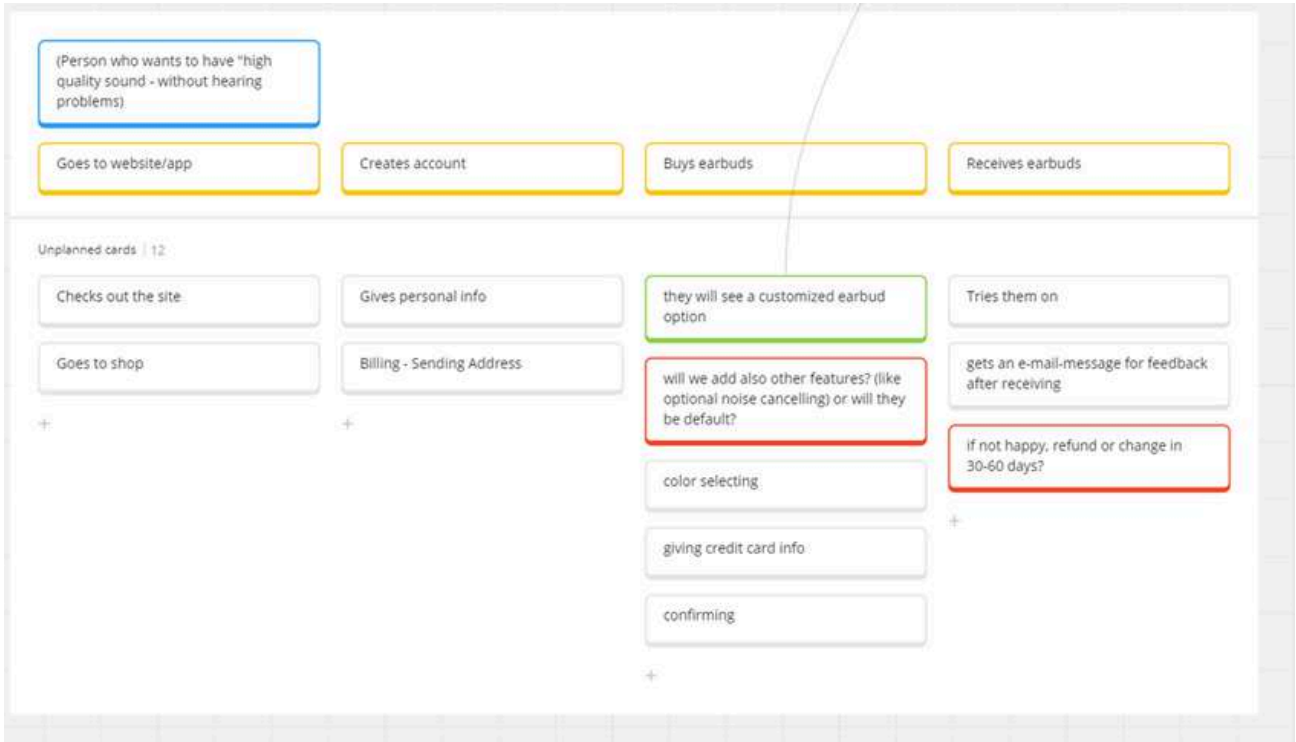




2. User Journey and Usability

Intuitive Navigation: Ensure that the website is easy to navigate, with clear menus and a logical flow from one section to another.
Customization Workflow: Simplify the customization process with step-by-step guidance, from selecting a base model to finalizing personalized options.





3. Design and Aesthetic preferences

Visual Appeal: Use high-quality images, sleek design elements, and a modern aesthetic to create an engaging user experience.
Brand Consistency: Maintain a consistent brand identity across all pages, using the same color schemes, fonts, and logos.

4. Testing and Feedback

Usability Testing: Conduct thorough usability testing with potential customers to identify any issues and gather feedback on the user experience.
Iterative Improvements: Continuously improve the webpage based on user feedback, ensuring it meets the highest standards of functionality and design.

Grenoble ATTRACT Pre-Final Conference

Our team was selected to bring a representative member to the ATTRACT Pre-Final Conference on the 12-13th of June, a great opportunity to show our work and make further tests with users.

Firstly, we had to prepare a few slides to briefly present our solution to the experts of the ATTRACT community, as part of the CBI.ATTRACT students' program. For us this was an additional chance to understand which were the main points to be highlighted during the presentation, in order to allow the audience to quickly grasp the problem and the troubleshooting concept behind the final idea. Since we had one minute to present, we chose to make one slide about the general problem: 1.5 billion of people suffer from hearing loss globally and, out of these people, less than the 10% choose to wear a hearing aid and treat their problem properly. This information introduces the reason why we chose that solution: we wish to build a bridge between that 90% of people and the hearing aids, in order to allow them to start being aware of their issue and to address it by using a non-medical device. We explained that this idea came out because, generally speaking for users that we interviewed, using medical equipment like that has strong psychological implications, as mentioned previously. All things considered, the main points of the solution explanation were:

1. The Glass2Mass customizable diaphragm;
2. The customizable inner channel shell;
3. The advanced AI features make the device adapt to every sound situation.

Once we did this one-minute pitch, we collected a lot of feedback in terms of clarity of the delivered message. What significantly came out was that people tended to see our product as a device to help with all the spectrum of hearing problems, so we definitely had to change data in order to make them focus on mild or moderate ones. Despite the lack of communication, the storytelling was really appreciated, so we had a great basis to work on for the final milestone.

1.5B

People suffer from some degree of hearing loss globally

The second day program also included a time slot to showcase our prototypes, so we worked a lot to be present there with a first tangible version of the idea

What we managed to bring in that space were:

- Team and Project posters;
- Four different 3D printed designs with a model of standard ears to test the comfort;
- A prototype of the product website.

Moreover, we studied a strategy to make people have an impactful and complete experience, in particular the user journey we thought consisted in:

1. Give to the user one or a pair of earplugs and make him/her walk around and talk to people, to experience how a partial hearing loss feels like;
2. Once the user feels the problem, they have the curiosity to discover a possible solution, so they can start to navigate through our website to learn more about the product;
3. If the website produces the desired results, the user now wants to see the real product, so we show the alternatives to them asking for which one they prefer, what they think we can improve, and which are the weakness/strength points of our designs.
4. Finally we provide further information on the technical aspects of our idea, if asked, to collect feedback also on the different functionalities and on the overall production system.

The observations made by experts, other students and tech partners can be summarized in the following points:

- Someone asked if we thought about doing different sizes for the outer shell;
- Some people worry about the safety of the diaphragm because of the material, so they suggested a modular internal architecture to easily substitute the damaged components;
- The favorite design was the one on the poster from the aesthetic point of view, but it seems too small to be stable in his position inside the ear, characteristic that the JBL-like model seems to have;
- For what concerns the website the main point was to rearrange the page that shows the three versions of the product, to better highlight the differences between them.

Starting from the first sketch of the prototypes we had the possibility to work on them, helped by the collected advice to focus on weaknesses or interesting points of the ideas. It is important to notice that these two intense days were also an excellent opportunity to meet people from around the world and to see how they faced today's global challenges using ATTRACT technologies. Changing perspective always helps to think outside the box, and this was our goal from the beginning of the program!

CONCLUSION

Final Reflections and Future Developments

After four months of dedicated effort, the Glass2Mass team has successfully leveraged advanced glass technology to develop an innovative solution: custom-molded earbuds. These earbuds not only promise to revolutionize the audio industry but also offer significant user benefits through customization and stigma reduction. By tailoring earbuds to individual auditory needs, we address a critical gap in the market for both audiophiles and those with mild hearing impairments, thereby enhancing user experience and accessibility. This project has been an invaluable experience for all team members, fostering both personal and professional growth and expanding our knowledge into previously unexplored fields.
Moreover, the project facilitated the development of new networks and friendships, creating lasting memories and experiences that will endure well beyond the project's completion.

Looking ahead, if this project evolves into a business, the first step will be to validate the market for our product. This involves conducting thorough market research to understand consumer needs and preferences, ensuring our earbuds meet the highest standards of quality and functionality. Following this, we will focus on creating the first functional prototypes integrating the advanced glass membranes in collaboration with our technological partner, Glassomer. This partnership is crucial for leveraging their expertise in glass technology to enhance the durability and performance of our earbuds.

Our strategic plan includes entering the Italian market, chosen for its robust consumer electronics sector and favorable business environment. We will employ an iterative product development process, continually refining our earbuds based on user feedback to ensure they meet the evolving demands of our target audience. This user-centric approach will help us build a product that truly resonates with consumers.

The positive feedback and potential investor contacts we received from various startup founders during the last project presentation have been particularly encouraging. These conversations have provided valuable insights into the startup ecosystem and have opened doors to potential funding opportunities. Engaging with experienced founders has not only validated our business idea but has also provided us with strategic advice on scaling our operations and navigating the challenges of a startup.

In conclusion, the Glass2Mass project has laid a solid foundation for future success, blending cutting-edge technology with innovative thinking. The journey has been transformative for the team, equipping us with new skills, experiences, and connections that will be instrumental as we move forward. With a clear vision and strategic plan in place, we are poised to bring our revolutionary earbuds to market, offering unparalleled value to users and making a significant impact on the industry.