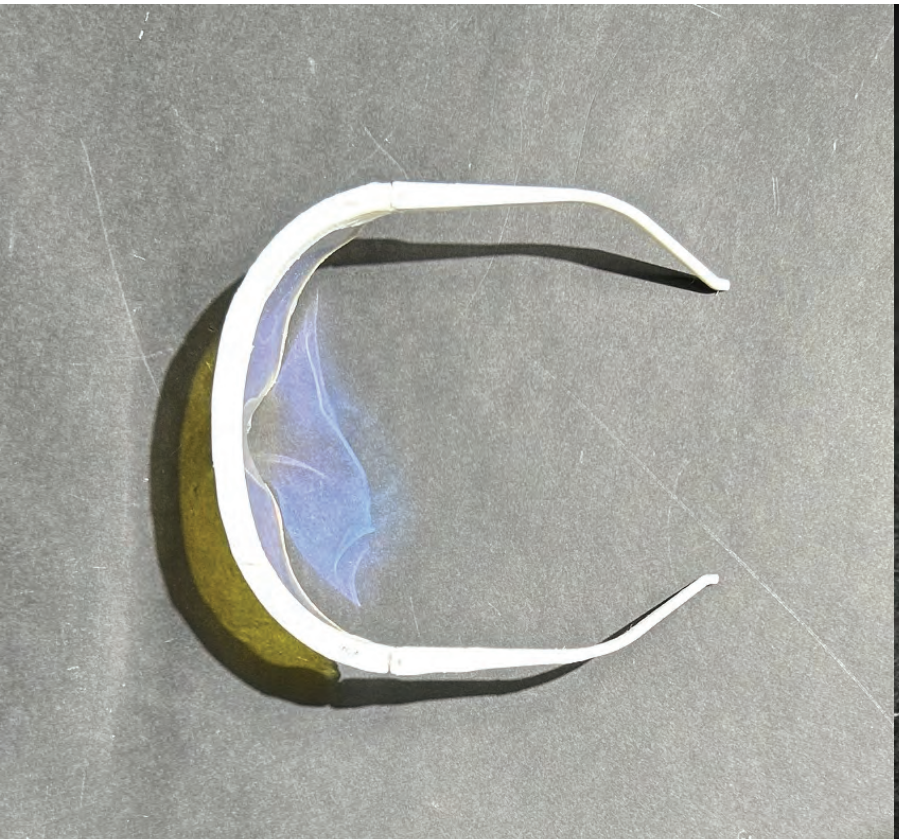
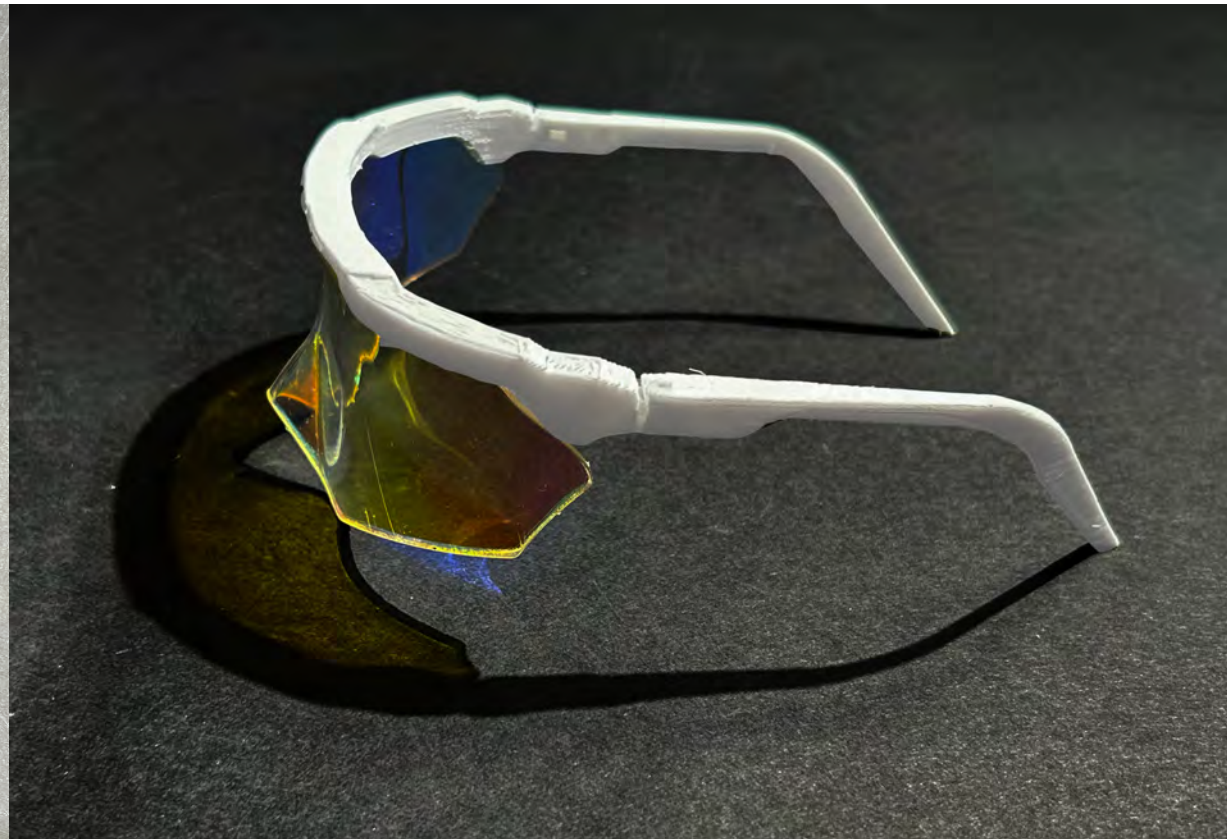
# BERG

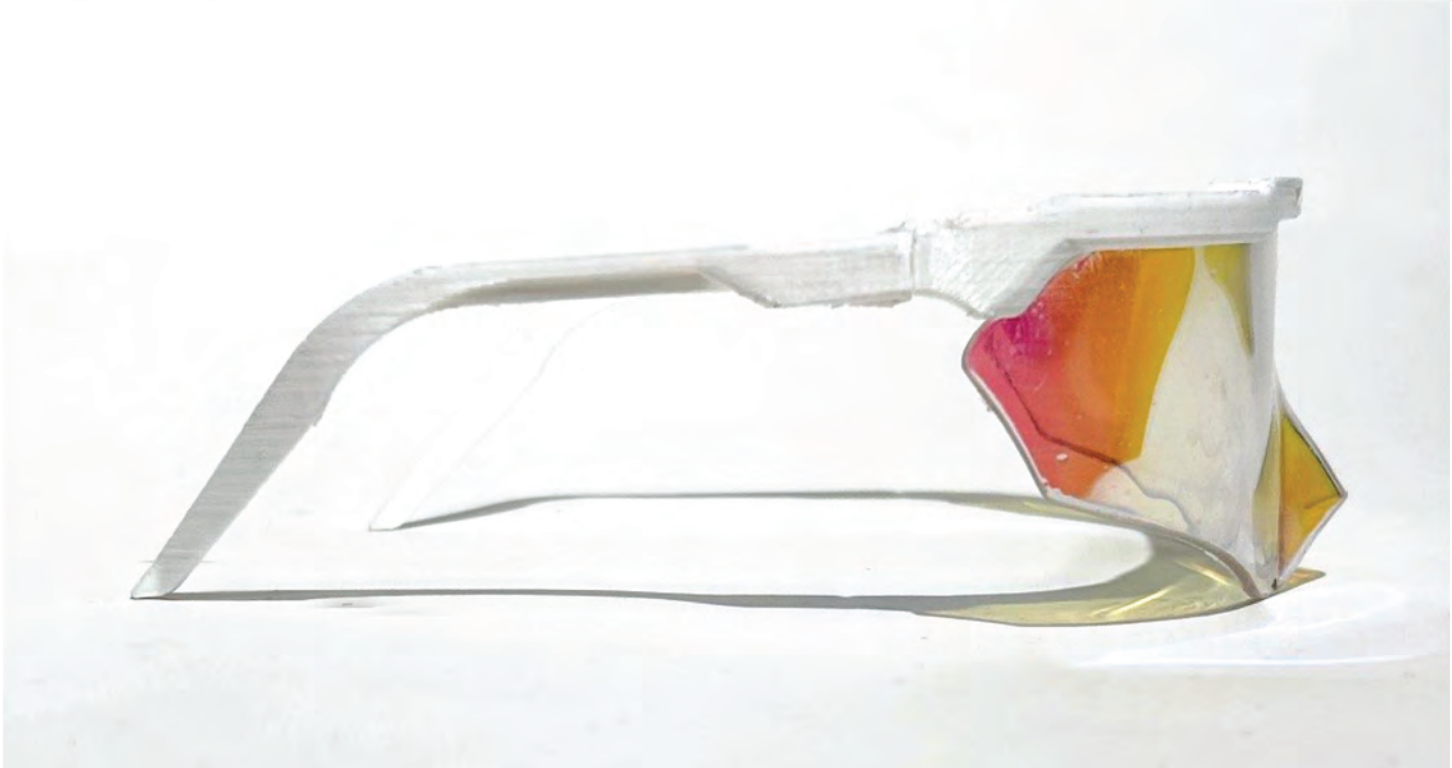
BEE KIM ETHAN ANGUS RICHARD PAN CHEN DI LI

# TABLE OF CONTENTS

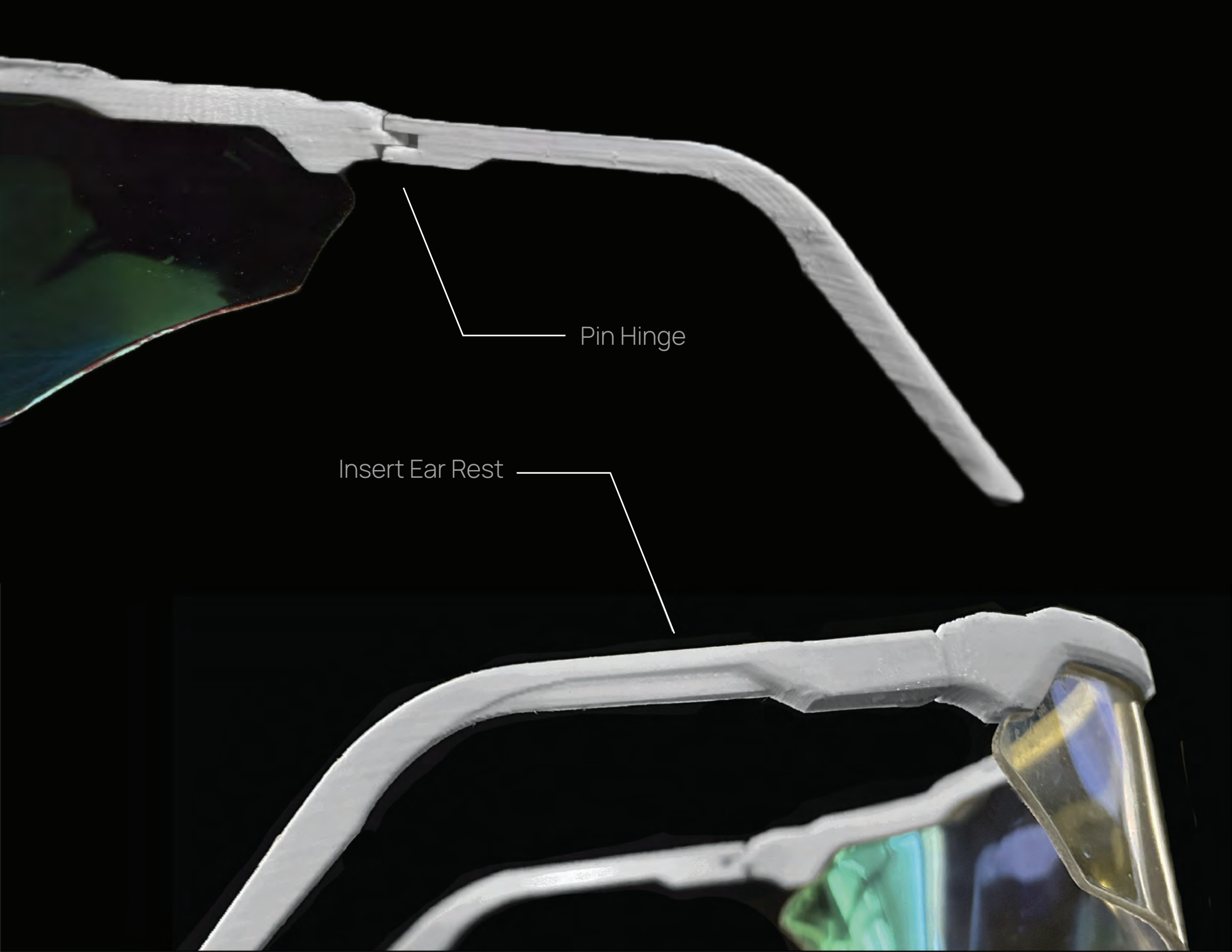


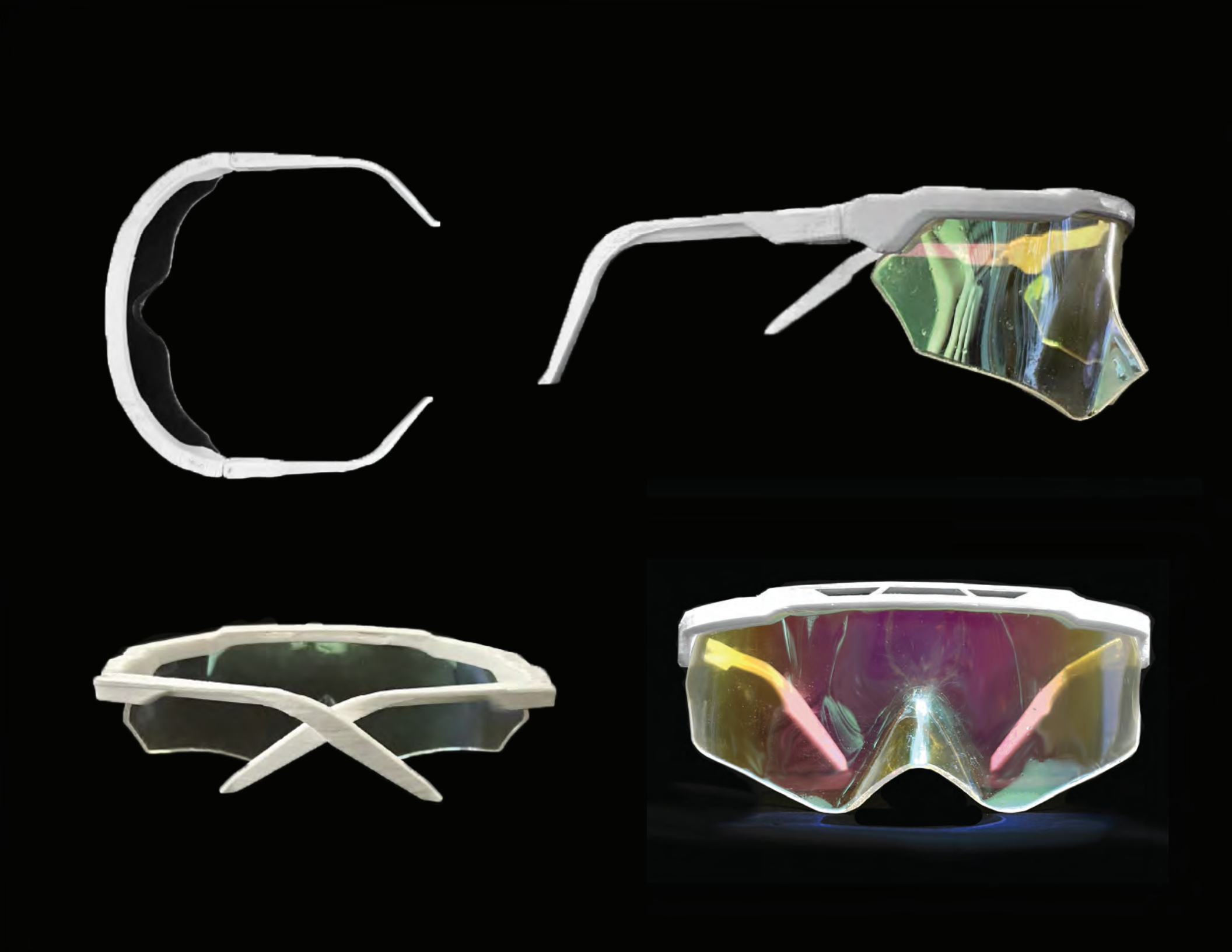




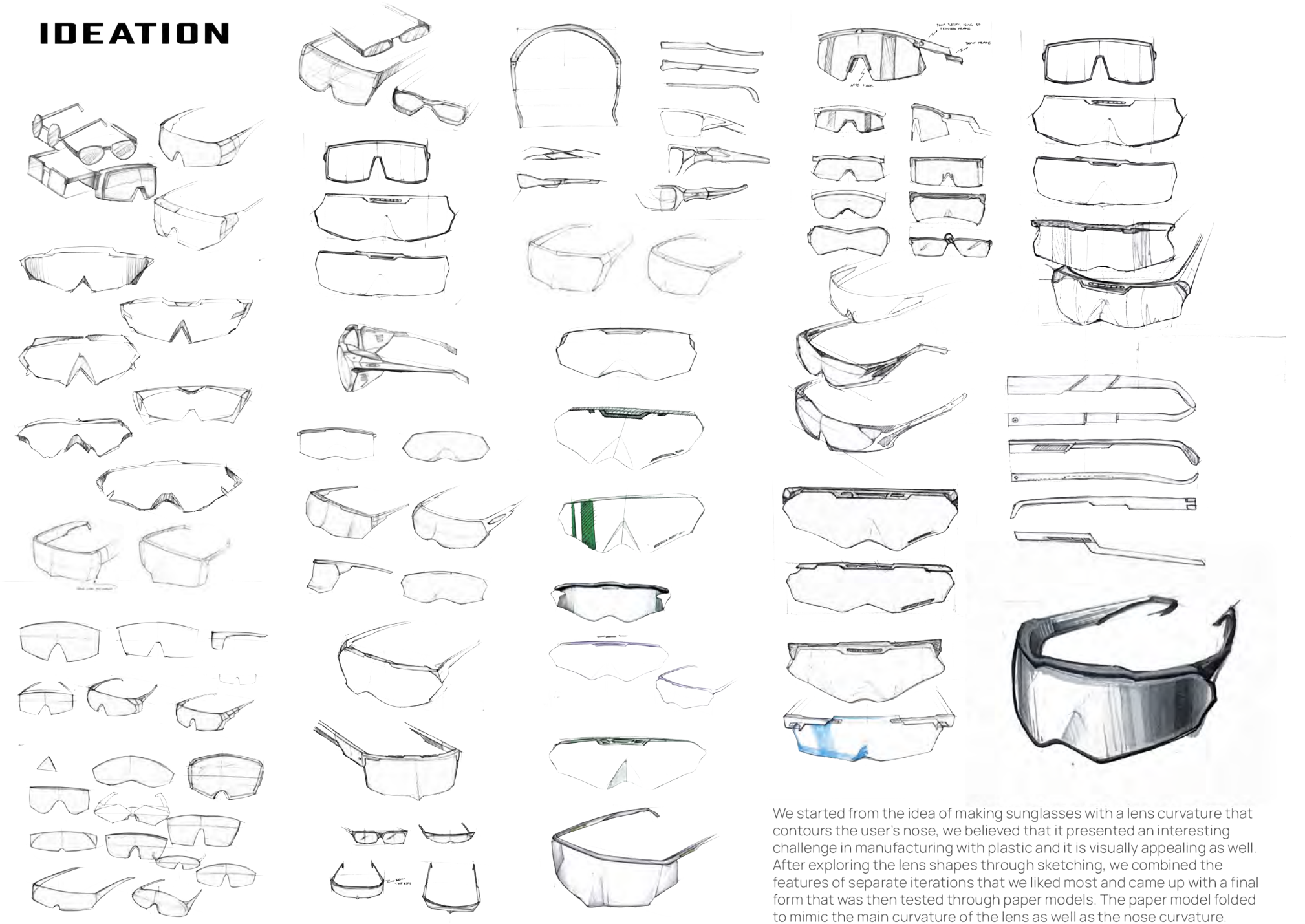


The BERC sunglasses embody an aerodynamic, eye-catching aesthetic, portraying a sense of speed and athleticism. The lens features a shape that seamlessly contours the user's nose providing a comfortable and unique look. Depending on the angle and light, the lens colors range from orange and purple, to green and blue.


Pin Hinge
Insert Ear Rest

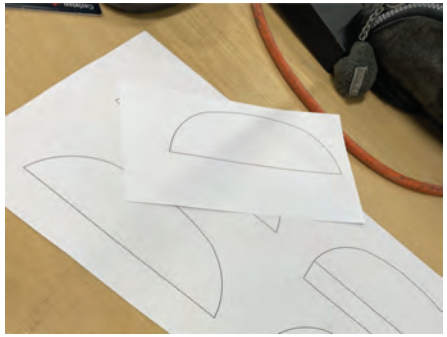


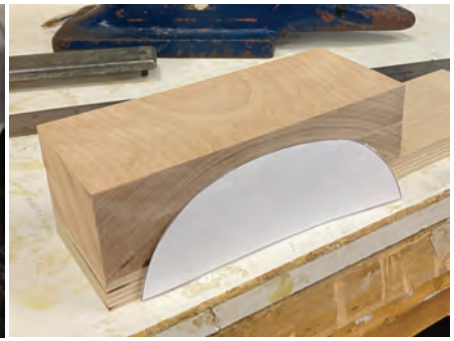
# IDEATION

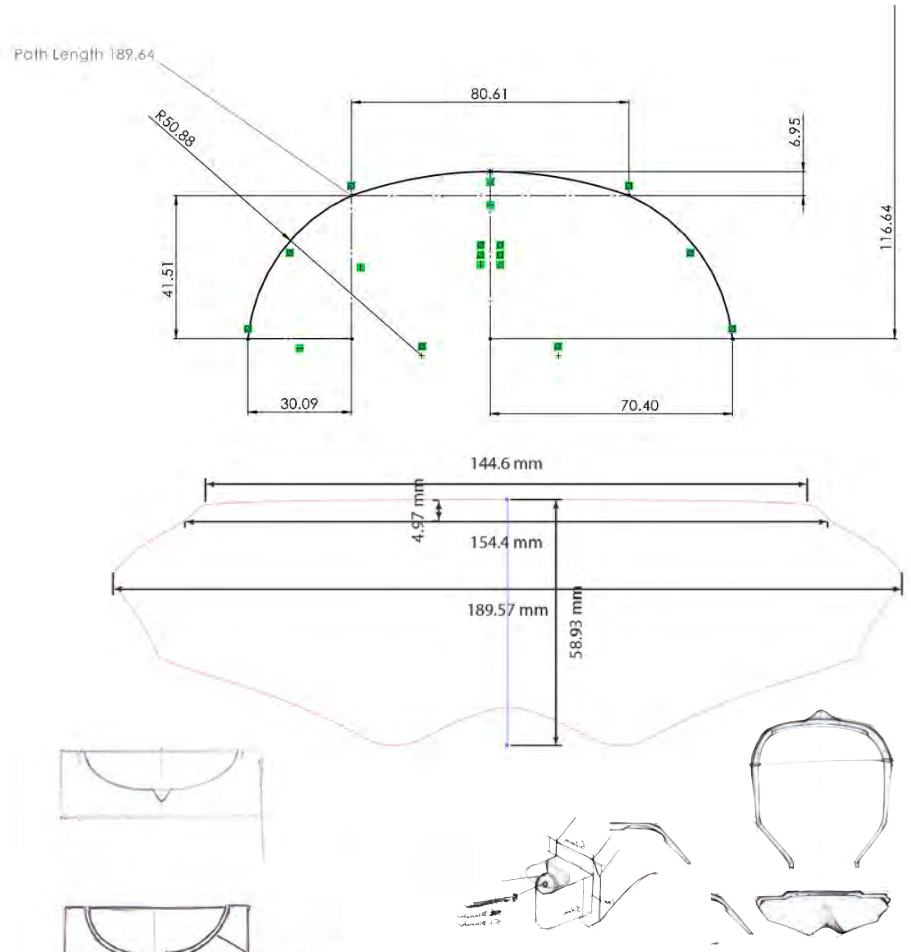


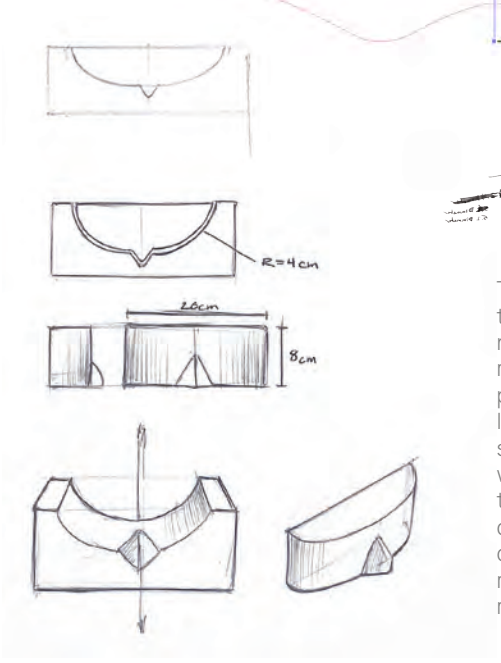
We started from the idea of making sunglasses with a lens curvature that contours the user's nose, we believed that it presented an interesting challenge in manufacturing with plastic and it is visually appealing as well. After exploring the lens shapes through sketching, we combined the features of separate iterations that we liked most and came up with a final form that was then tested through paper models. The paper model folded to mimic the main curvature of the lens as well as the nose curvature.

# FINDING DIMENSION



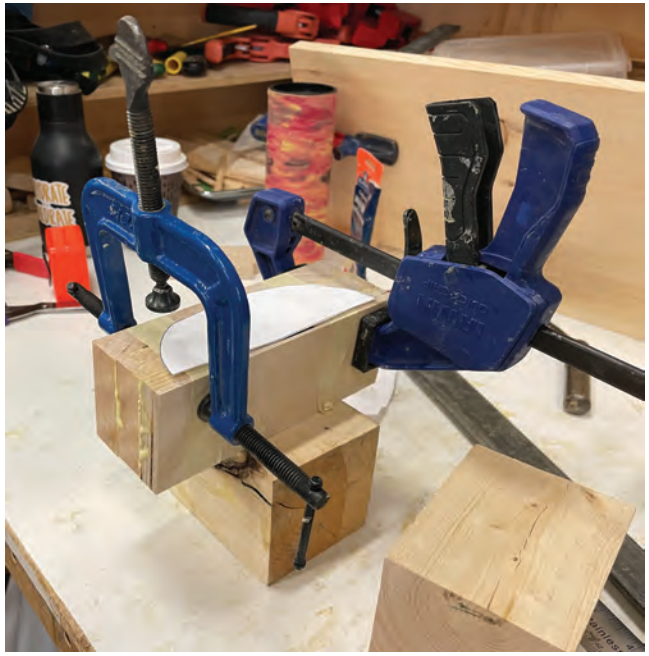





The lens' dimension in its flat form was taken from the paper model. We referenced the radius needed for the main surface curvature from an existing pair of glasses, and did drawings of the lens' curvature from the top view in solidworks. The profile of the curvature was then printed out and cut out to be traced, for replicating the same curvature to make the jig. We found the dimension of the nose curvature by measuring someone's nose to see how much lift is needed.

# LABORATORY DOCUMENTATION



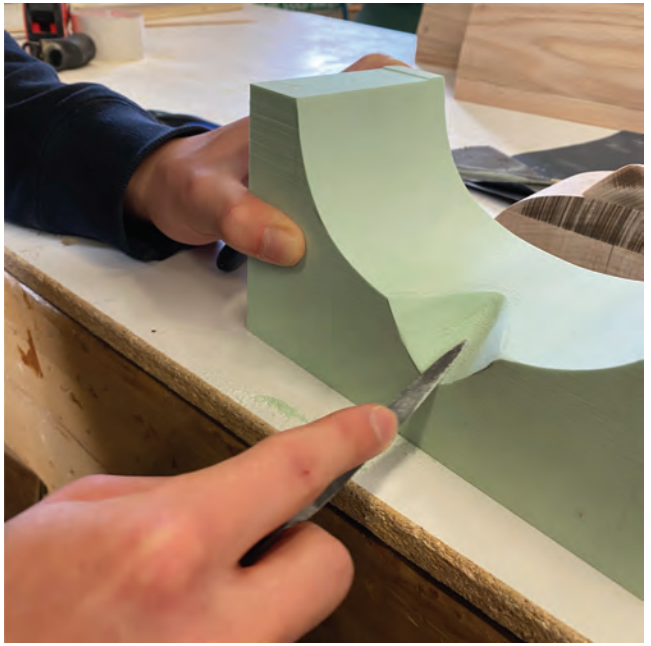
**Mold Making part 1**

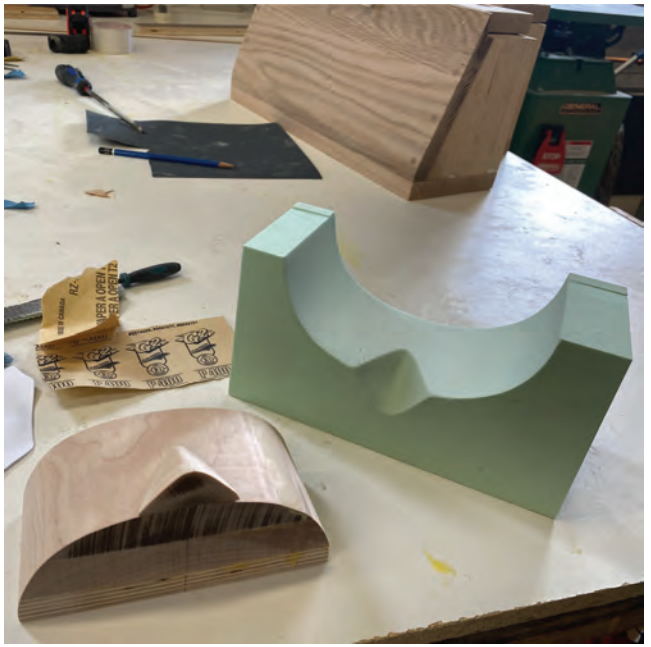
For the positive tool, we cut and glued together 3 wood planks to have enough thickness to cover the entire curvature. The glued piece was then cut with a band saw and sanded on the belt sander to form the curvature. It was sanded to 1200 grit by hand to ensure a smooth finish on the lens. The nose piece was made separately by cutting out a piece of pyramid shaped wood then sanded. To complete the male tool, the nose piece was glued together with the main curvature piece (after the negative tool was made).

## Mold Making part 2

The negative tool was made with high density foam,  cutting out the main curvature with a bandsaw, then sanded smooth to 1200 grit. It was important to leave a 1/16th of an inch gap between the male and female tool for the lens. After that, the nose shape was sanded until the positive jig could fit in perfectly, then sanded a bit more to account for the thickness of the lens as well.

The most challenging part of the process was creating the nose shape into the negative mold, as it is an organic shape, and it was important to ensure the shape was precise so it would fit the male tool.



### Thermoforming

Using a PETG plastic, we lazer cut lenses using our illustrator file dimensions. The cut lens was heated using a heat gun until it became pliable and would conform to the curvature. Then the lens was swiftly moved into the mold to be pressed. The thermoforming process would require two cycles. The first heating cycle and press would get the overall curvature. After our initial attempt, we experimented with positioning the plastic sheet onto the negative mold during heating.


For the second cycle, we could properly align the nose of the lense, then heat the nose curve once more, and apply pressure with the male tool to achieve the final form.

The greatest challenges during the thermoforming process were keeping the lens parallel to the mold, and pressing the plastic down into the nose-part of the mold while keeping an even curvature for the rest of the lens.


**Attempting to thermoform the lens and film together**

The film did not stretch as expected to the same shape as the lens, leaving bubbles and creases. The bubbles also left marks on the surface damaging the whole lens

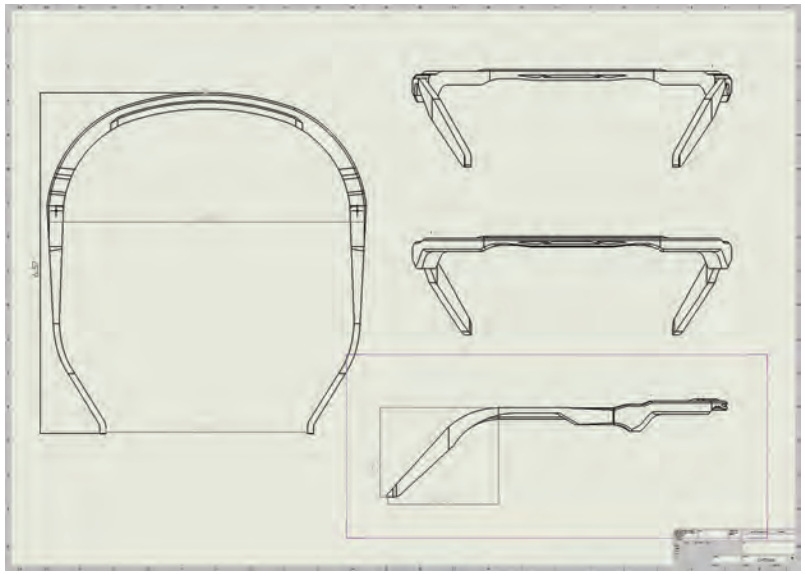
**Applying the film with heeat gun**

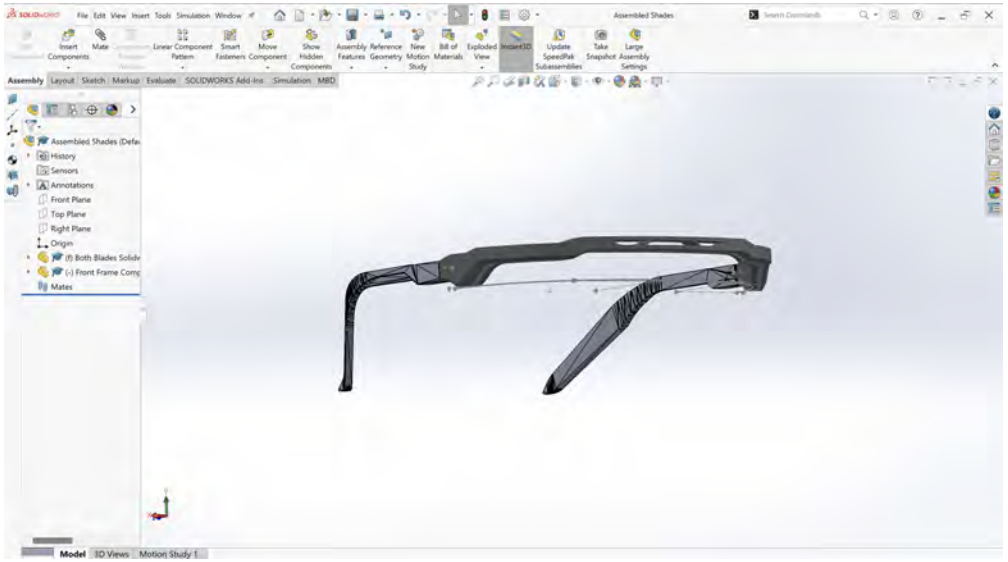
We stuck the film on the lens and smoothed it out with our fingers. We tried to heat the area of the nose more to make the film stretch. However, we encountered unexpected deformation of the film at a specific temperature threshold. This process left bubbles as well.

**Using a separate piece of film for nose contour, and applying without heat**

This method created the best result. The number of air bubbles was significantly reduced compared to previous methods. Excess material was trimmmed off and sanded to the edge.

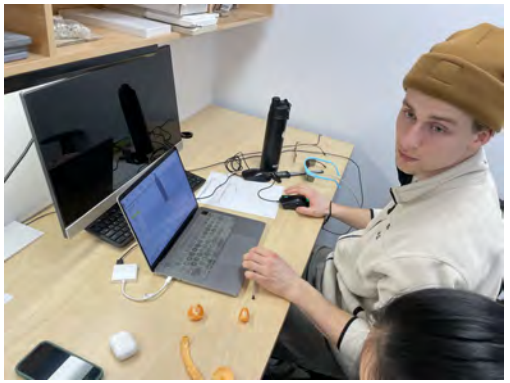
# 3D MODELING

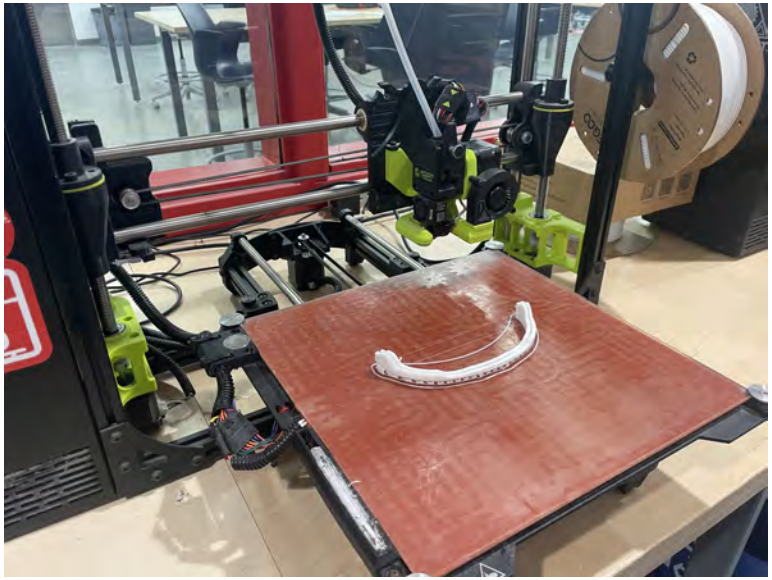


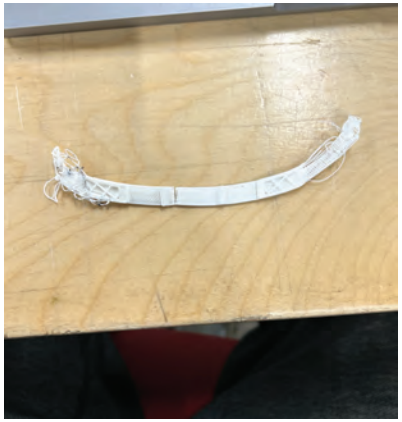


The blades were based off of the front-frame, and measurements were referenced from pre-existing sport glasses. As is often the case with Solidworks, most every detail added came with a problem that had to be overcome.

The hinges were the final addition, which were modeled for a pin-joint, based on the pit-viper screw joint.








### 3D Printing

The 3D printing process took a few attempts, the first model was not designed with proper supports, causing the printer the malfunction while attempting to print in mid-air, releasing filament randomly and scraping along the pre-existing print.

For the second attempt, we added support for the entire base of the frame, but that left unattractive marks on the top-side of the front frame. The lens was also too thick for the frame slot, so that had to be expanded.

For the final model, a 5cm print bed was added, the front-frame piece was dropped down to the bottom level, and the gap for the pin-joint was increased

### Assembly

To refine the 3D printed sunglasses frame, we initiated by sanding off any excess plastic, ensuring a smooth and polished surface. This step is crucial for enhancing both the appearance and comfort of the frame. Next, we carefully drilled a notch into the frame to accommodate a pin, which would serve as a sturdy hinge for the sunglasses' legs. This process ensured that the hinges would function seamlessly, providing durability and flexibility. With the hinges securely in place, we proceeded to attach the lenses to the frame, ensuring a snug and secure fit. Finally, we polished off any remaining flash or excess material, resulting in a sleek and professional finish. This comprehensive process transformed the 3D printed sunglasses frame into a stylish and functional accessory.

### Ethan

This project was an incredible learning experience for me. The greatest areas of improvement I feel I developed were in my sketching abilities, Solidworks, and leaps and bounds in my understanding of plastics and thermoforming. Working on glasses allowed me to explore a new market of design, which I found extremely enjoyable.

### Chen Di

This project provided valuable learning experiences for me. I gained insights into how negative and positive mold pieces interact and the appropriate materials for crafting these molds. Additionally, I view this project as an effective introduction to considering ergonomic design aspects related to the human head.

There are a few areas we would like to explore to push this project further.

- First of all, the mechanism in the handles is ergonomically limiting, and does not accommodate a large range of people. The pin hinge lacks rigidity. A pressure-hinge would be far more resilient and effective.
- Secondly, we would add a nosepiece to make the glasses feel more secure. Changing the angle by-which the glasses fit into the frame to angle the base of the lens towards the nose would make the lens sit better on the brim of the nose.
- The top of the frame had some clear 3D print lines from the supportive material. Thickening the support material, or flattening the top brim design would leave a cleaner finish for the front of the frame.
- The holes we made in the frame, though aesthetically pleasing, were hard to finish cleanly as the gaps are so small.
- Applying the film always resulted in some degree of bubbling. Finding a different material for the film and researching different methods to stretch and apply the film could produce a cleaner result.
- Periodically sanding the foam-female tool would have yielded better results, as the shape would incrementally deform over-time.
- The film is also not polarized, and would benefit functionally if it were.
- Finally, there are some small gaps between the frame and the lens. Closing these gaps through redesign of the mold with smaller tolerances would yield a better fit.
- We encountered difficulties centering the nose of the flat lens when molding. A system for constraining the two mold pieces and the plastic in place during clamping mold would yield more accurate, consistent lenses.

Despite all of these areas for improvement, we are extremely proud of what we created, and hope you enjoyed it too.

Best,

Richard, Chen Di, Ethan, Bee

### Richard

Through this project I learned about the process of thermoforming with a male and female tool, and gained knowledge about different polymers' properties like PETG, acrylic, and PET and vinyl films. I feel that I developed my wood working skills further from making precise molds of complex shapes. It was very enjoyable collaborating to come up with a pleasing result in the end.

### Bee

This project enhanced my grasp of plastic's physical properties, refined my SolidWorks proficiency, and deepened my expertise in creating diverse joints for plastic products. Moreover, it provided valuable insights into heat-forming techniques and the importance of jig-making in manufacturing processes.

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