Johnson Health Tech: VO2 Mask for Biomechanics Research

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Overview

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- Background Information
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Johnson Health Tech

- Manufactures and develops exercise equipment
- Based out of Cottage Grove, WI
- Utilizes a biomechanics lab to test equipment
- Support and validate claims with research
- Competitor comparison

Figure 1: Johnson Health Tech Logo [1]

Problem Statement

- Objective: Design a mask for measuring volume of oxygen consumption that is compatible with glasses
    - Provides maximum safety and comfort for user
    - Quantitatively prove that the mask produces accurate VO_2 metrics

Figure 2: Current VO_2 Mask Model [2]

Background: VO2 Max Aerobic Testing

- VO_2 max tests are used to determine aerobic fitness of athletes
- Athletes wear a VO_2 mask with an intake tube while training
- Measures oxygen usage and consumption
- Johnson Health Tech and other manufacturers have already used and developed VO2 masks that successfully quantitate aerobic capacity
- Athletes with glasses were at a discomfort when wearing the mask

Figure 3: VO_2 Max Testing Set-Up [3]

Background: Competing Designs

- VO_2 Master Pro
  - Uses a silicone mask, accurate, battery-powered, portable
- CardioCoach
  - Uses a silicone mask, machine-powered, accurate
- K5 Metabolic System
  - Uses a silicone mask, battery-powered, can conduct multiple tests

Figure 4: K5 mask [4]

Figure 5: VO_2 Master Pro Analyzer mask [5]

Figure 6: CardioCoach mask [2]

Product Design Specifications

- Allows subjects to wear glasses during VO_2 testing
- Total cost is below $400
- Can withstand up to 20 minutes of VO_2 testing
- Is debris resistant (internal/external)
- Can be cleaned between uses
- Is able to perform VO_2 tests accurately

Design 1: Clamps and Lower Bridge

- Nose bridge is lowered an inch to place glasses
- Two clamps added on the sides of the mask to hold glasses from the side
- All other components remain the same as the current mask

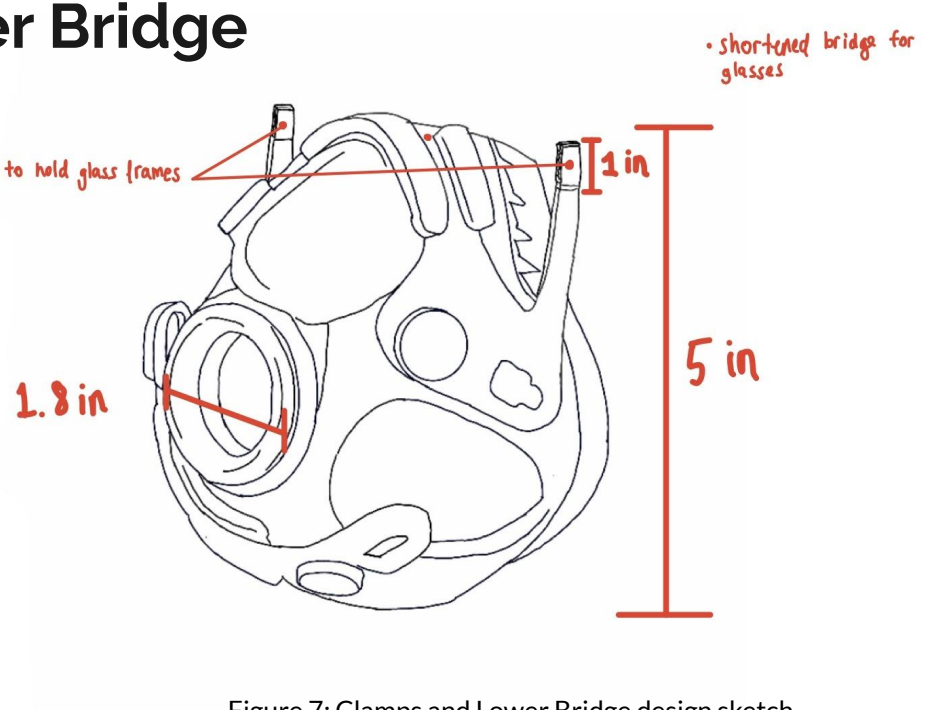


Figure 7: Clamps and Lower Bridge design sketch

Design 2: Divot

- A divot is added on to the top of the mask to place the glasses
- The divot would be an inch by an inch and would not affecting the vision of the user
- All other components remain the same as the current mask

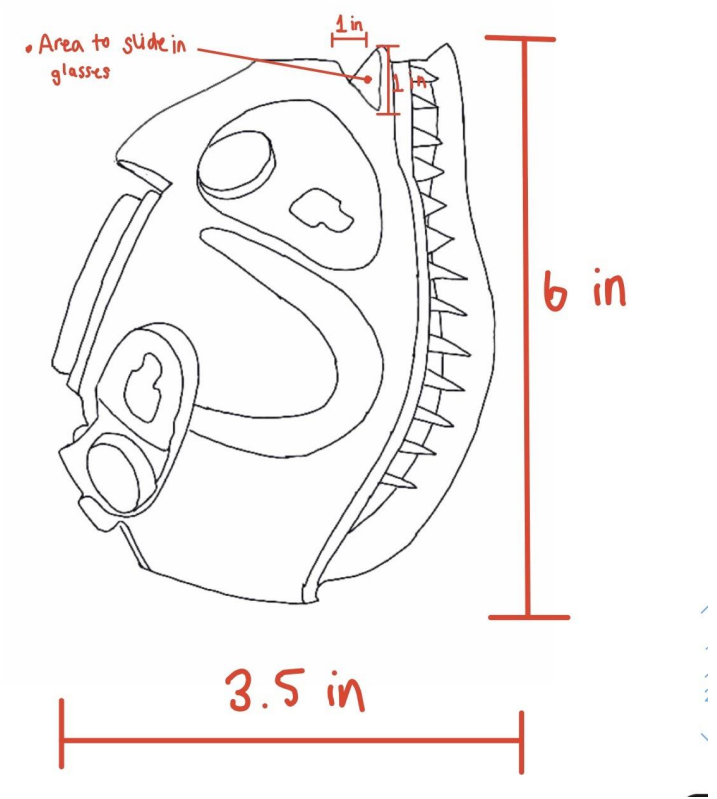


Figure 8: Divot design sketch

Design 3: Nose Clip

- Separate nose clip to cut off air exchange via the nose
- Mask only covers mouth, so bridge is shortened
- All other components remain the same as the current mask

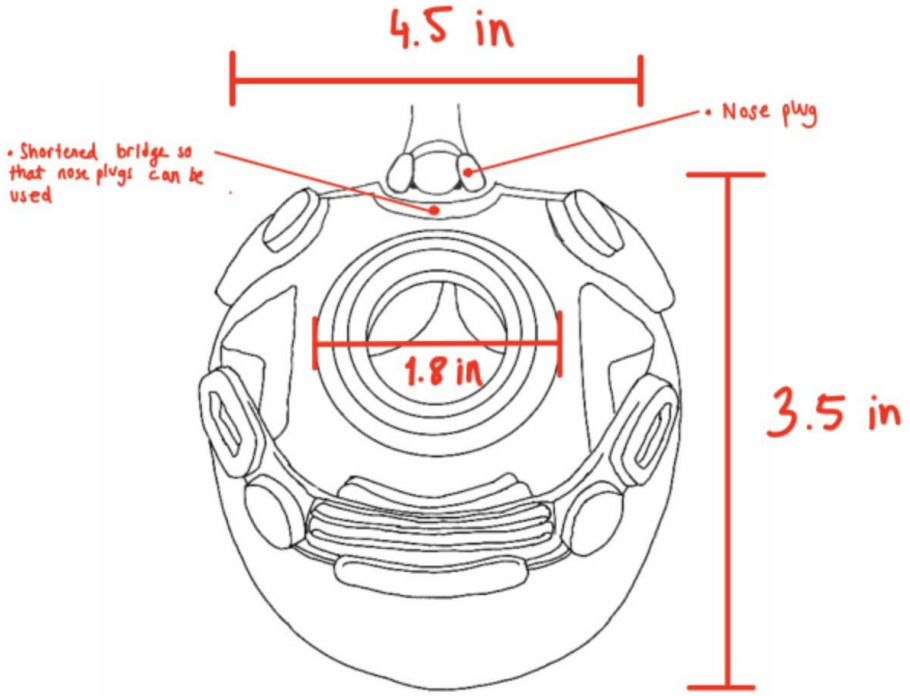
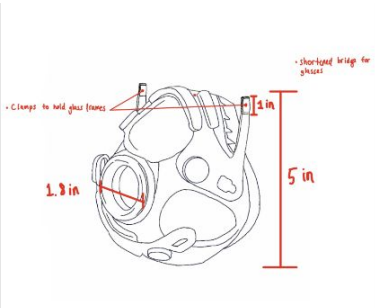
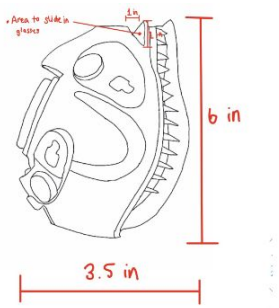
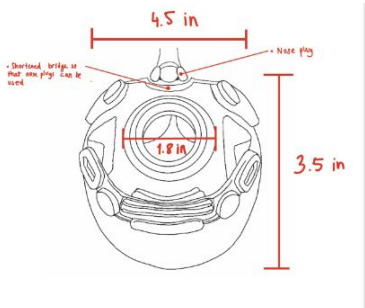


Figure 9: nose clip design sketch

Design Matrix







Criteria	Weight	Design 1 - Clips and Lower Bridge		Design 2 - Divet		Design 3 - Nose Clip	
Comfort	25	3/5	15	2/5	10	1/5	5
Accuracy	25	5/5	25	3/5	15	2/5	10
Durability	20	3/5	12	4/5	16	4/5	16
Ease of Use	15	4/5	12	5/5	15	3/5	9
Safety	10	5/5	10	4/5	8	4/5	8
Cost	5	5/5	5	5/5	5	5/5	5
Total	100		79		69		53

Figure 10: Design matrix for the three potential designs

Final Proposed Design

- Three clamps to secure glasses
  - Left and right sides to secure frame
  - Middle to secure bridge
- Minimal change in height of nose piece
- All other components remain consistent with existing masks, including materials
- Design is subject to change

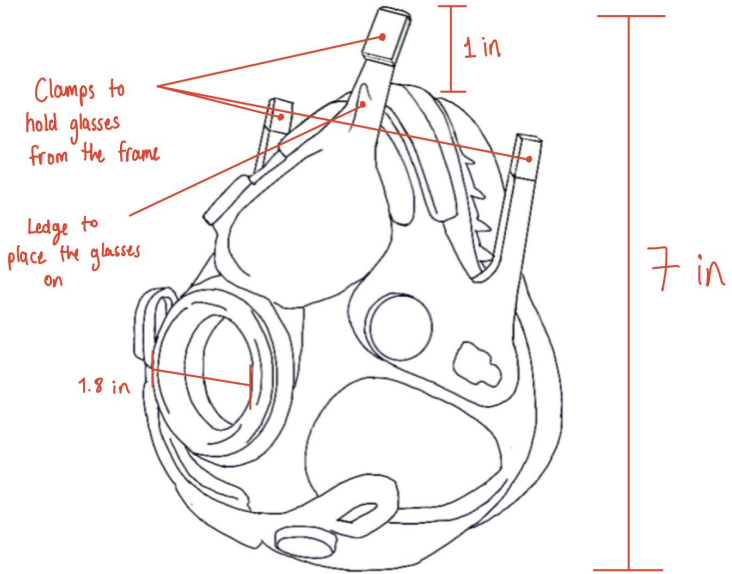


Figure 11: Final proposed design sketch

Future Work: Fabrication

- 3D scan of existing masks [6]
  - Modify in SolidWorks
- 3D printing at the Makerspace [7]
  - Materials
- Compatible with tubes and straps used with existing masks

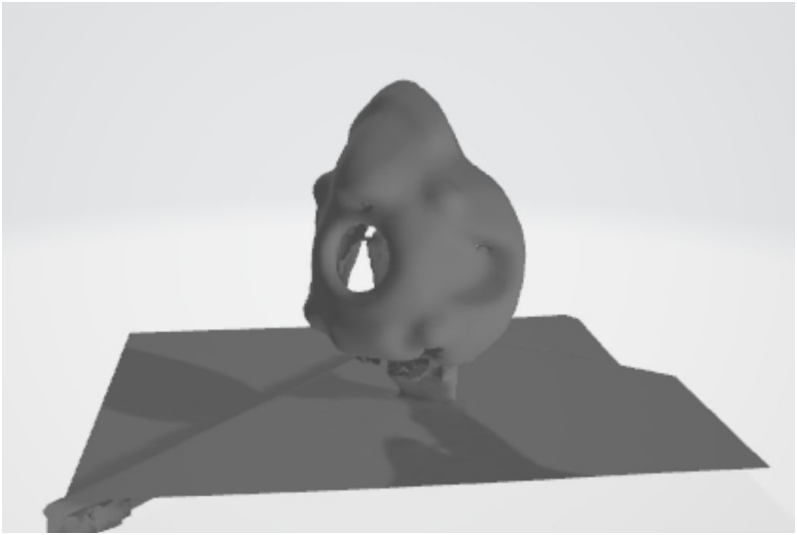
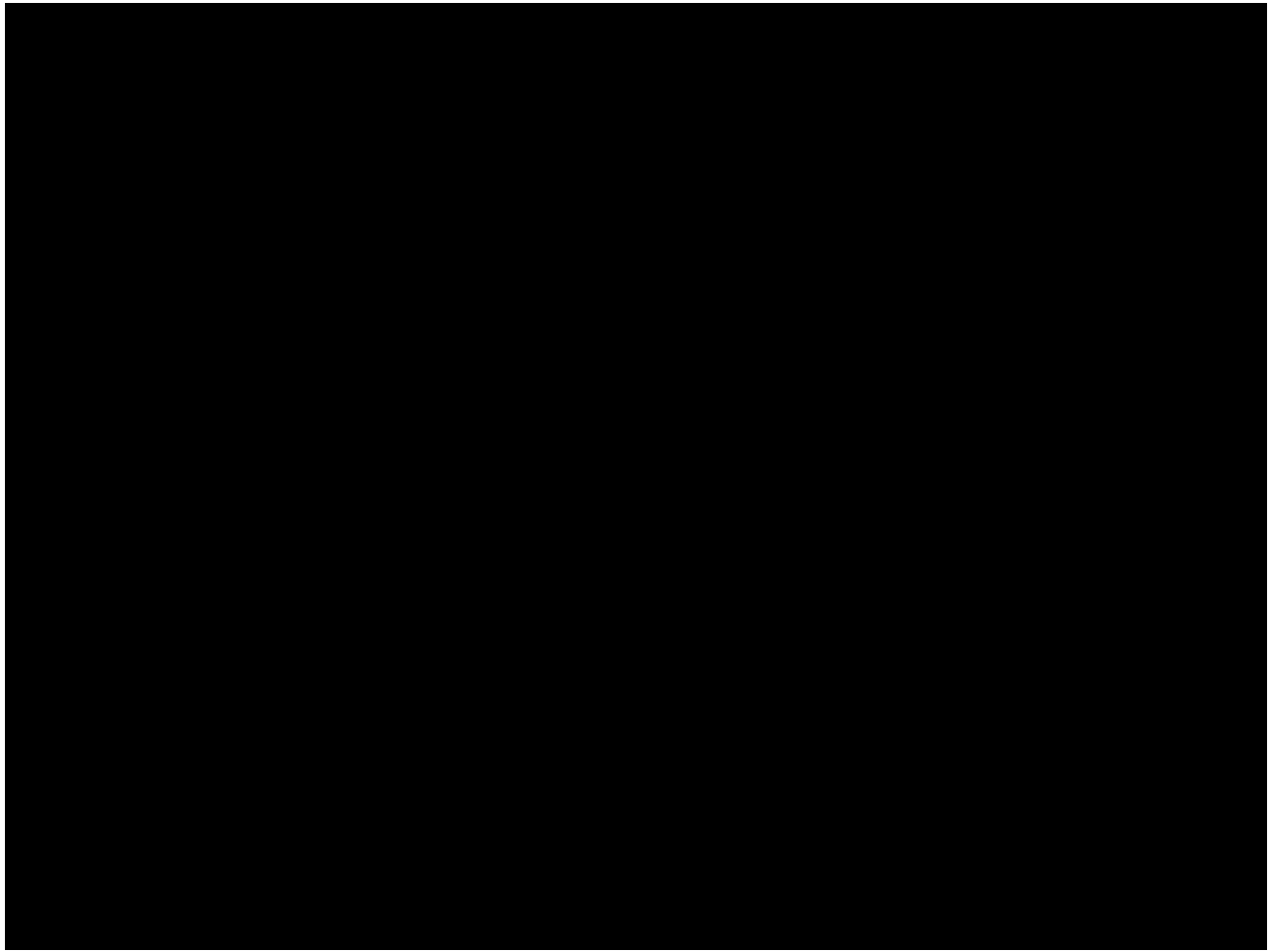


Figure 12: 3D scan of existing VO2 mask



Future Work: Testing

- Testing the design and comparing the results to the current masks used by Johnson Health Tech
- A participant will undergo a VO_2 max test with both masks
    - Following Johnson Health Tech procedures and conditions
- Using testing to show equivalent VO_2 measurements between both

Figures 13 and 14: Subject undergoing VO_2 max testing at Johnson Health Tech

Acknowledgements

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References

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