BME Design-Fall 2021 - VICTORIA HEILIGENTHAL
Complete Notebook

PDF Version generated by

RACHEL KRUEGER

on

Dec 15, 2021 @01:27 PM CST

Table of Contents

Team Contact Information

JAKOB KNAUSS - Sep 12, 2021, 9:35 PM CDT

Last Name	First Name	Role	E-mail	Phone	Office Room/Building
Ludwig	Kip	Advisor	kip.ludwig@wisc.edu		
Trevathan	James	Advisor	jtrevathan@wisc.edu		
Quam	Staci	Client	Staci.Quam@johnsonfit.com		
Heiligenthal	Victoria	Leader	vheiligentha@wisc.edu	2488214649	
Krueger	Rachel	Communicator	rjkrueger4@wisc.edu	8477077859	
Knauss	Jakob	BSAC	jaknauss@wisc.edu	6086096216	
Kriewaldt	Tommy	BWIG	tkriewaldt@wisc.edu	6088076650	
Rasmussen	Adrienne	BWIG	ajrasmussen4@wisc.edu	2065126339	
Ozturk	Sinan	BPAG	sozturk3@WISC.EDU	6085048381	

Project Description

JAKOB KNAUSS - Dec 13, 2021, 3:54 PM CST

Course Number: BME 200/300

Project Name: JOHNSON HEALTH TECH: VO2 MASK FOR BIOMECHANICS RESEARCH

Short Name: Vo2 Mask for Biomechanics

Project description/problem statement:

Metabolic tests, such as VO_2 max tests are important in determining the cardiovascular and aerobic fitness of athletes. During VO_2 max testing, athletes wear a VO_2 mask with an intake tube while performing an intense and high level form of exercise, like running or biking, until maximal effort and complete exhaustion. The concentration of oxygen inhaled and carbon dioxide exhaled are collected through the mask to determine how much oxygen the athlete uses during exercise as well as the maximum concentration of oxygen consumed. The more oxygen consumed, the more efficient the cardiovascular system is working. This means more oxygen can be delivered to the muscles, generating a greater energy output and enhancing physical performance. There are VO_2 masks used during testing currently on the market, but improvements can still be made to make the testing more comfortable for participants. Johnson Health Tech, an exercise manufacturing and research company, has faced problems with testing athletes that wear glasses while performing VO_2 max tests since they cannot wear their glasses with the masks. The design must be comfortable, prevent leakage, and allow for the athletes to wear glasses during testing.

About the client:

Ms. Staci Quam
Engineering
Johnson Health Tech
Staci.Quam@johnsonfit.com

9/15/21 - First Client Meeting and Questions

VICTORIA HEILIGENTHAL - Sep 15, 2021, 10:24 AM CDT

Title: First Client Meeting and Questions

Date: 9/15/21

Content by: Victoria

Present: Victoria, Rachel, Jakob, Sinan (others had class conflicts)

Goals: To ask the client questions about their expectations for the design project and to introduce ourselves.

Content:

For our first client meeting, we introduced ourselves and asked our client (Staci Quam and Grace Johnson of Johnson Health Tech) to give us a general introduction to the project and what they are seeking from us. They told us why and how they use their current Vo2 masks and that the issue they are running into is allowing users with glasses to wear their glasses during testing. We followed up by asking questions relating to the project that we previously came up with to ask them. Notes from the meeting are below:

Intro:

- Vo2 system comes with a mask, you put it on, tubes that connect to it
- Users that have glasses = unable to wear them while wearing the mask
- When doing a high intensity workout, not being able to see what you're doing causes danger. So when people cannot wear their classes, it poses a high risk.
- Create a solution that allows users to wear glasses
- Two mask sizes currently, have worked for everyone except for people with glasses

Questions for client:

- Is there a specific material that the mask has to be made out of?

Usually rubber or silicone, free to prototype with other materials (3D printing)

- Other than being comfortable for users with glasses, what other improvements would you like to see from VO2 masks already on the market?

Making the improvement with glasses is the only issue they have come across so far, can provide us with one of the masks.

- What are the conditions the athletes are being tested at?

Want it to be a snug fit - goal is to make sure all the air is going through the mask to best measure the VO2, no leakage

- Is there a size or weight restriction for the mask?

Take the measurements of their current mask.

- What is the shelf life expectation for the mask?

Full cleaning in between uses, same mask but sanitation gap used.

- What is the budget you have in mind?

Getting back to us

- Is there a certain model of glasses we should make the VO2 mask for? Or should the design be able to support various models?

Mostly with standard glasses, account for the biggest glasses that you can. Athletic glasses, big glasses, small glasses, etc.

- How do we get access to the existing masks and tubes/valves from the Biomech Lab?

Meet up at engineering hall to get the 2 VO2 masks

- What is meant by two sizes of mask? Is that just based on face/head size?

Currently have two sizes, only problem is glasses-typically fit anyone

- What kind of exercise will the athletes be doing?

Used with treadmills, ellipticals, climbmills

- How long will this mask be worn for?

No longer than 20 minutes

- What are the demographics of the users?

Typically 25-62 years old.

- Are there any COVID restrictions we need to consider?

The mask should be designed for future use when COVID restrictions are no longer something to worry about or consider when designing the mask.

- How do you use VO2 max testing in your lab? What kinds of studies is this testing used to collect data for?

Data is used for research purposes and to support and validate claims wanted by people in the market. Also used to do competitor comparison.

The client is going to get back to us about the budget, the procedures and protocols they use during testing as well as providing us with two masks that they currently test with.

Conclusions/action items: This initial client meeting went really well. It was nice to meet our client, gain a better understanding of the project, and answer the questions we had so we can start outlining our research and design more clearly. We are scheduled to have another client meeting on Friday with Grace to go over what we discussed today as well as to introduce our other team members that could not make it to the meeting.

9/17/21 - Introduction Meeting

SINAN OZTURK - Sep 23, 2021, 10:02 AM CDT

Title: Client Meeting-9/17/21

Date: 9/17/21

Content by: Victoria

Present: Victoria, Rachel, Jakob, Adrienne, Tommy, Sinan

Goals: Sophomores introduce themselves to the client and we make more connections with each other

Content:

- Found out the budget: $400
- Grace cannot meet next week, meet in two weeks
  - Good because have to work on PDS and Preliminary Deliverables
- Grace and Rachel exchanged JHT masks
  - Instructions on how to construct are in the bag
- One size to start is good
  - Focus on bigger sized one first
- Asked about how glasses do not function on mask- glasses do not fit on mask
  - Mask goes too far up face of nose bridge and protrudes out
  - Cannot wear glasses with masks, makes people nervous and stress out (anxiousness)
- Going to reach out if we have new questions or if they have something new for us

Conclusions/action items:

- **Start working on PDS**
  Split up work and discuss what we need to research
- **Keep in contact with Grace and Staci**

10/1/21 - Client Meeting

RACHEL KRUEGER - Oct 01, 2021, 12:17 PM CDT

Title: Client Meeting

Date: 10/1/2021

Content by: Rachel Krueger

Present: All group members besides Sinan (BPAG meeting)

Goals: Get feedback on our design matrix.

Content:

Main feedback was making sure we do research to figure out how low we could bring the mask to make sure it still fits everyone

Maybe do a ball and socket design for the clips to account for all face shapes

Consider the divet design in case the bridge lowering is unable to be functional.

Have the possibility of leakage occurring if we lower the bridge too much - all nose shapes are different sizes.

Have to consider how all shapes and sizes of glasses factor in.

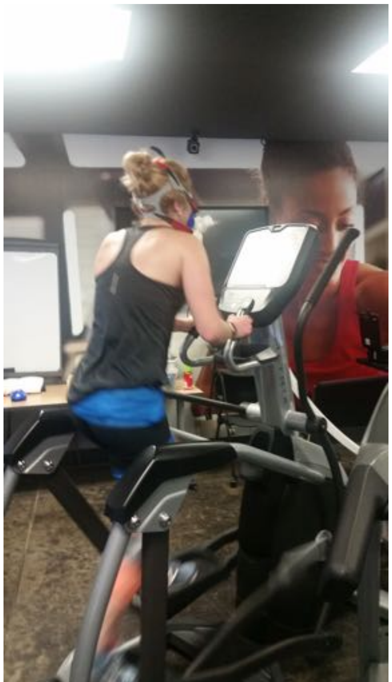
Conclusions/action items: Get answer on whether or not we have a solidworks model to work with. Get photos of past participants wearing the mask. Continue research. Plan to have some part of the PDS complete to show Grace at next client meeting.

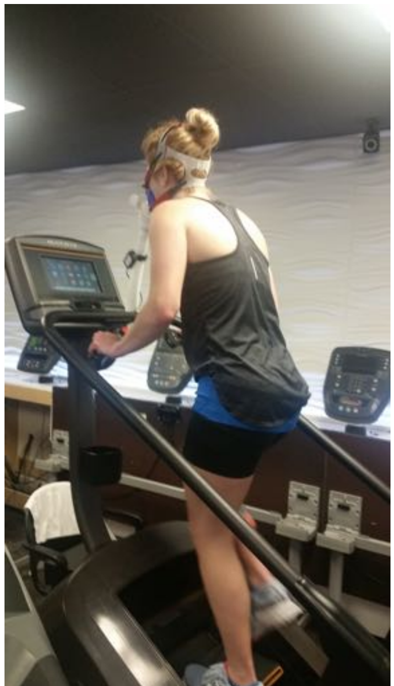
JAKOB KNAUSS - Oct 06, 2021, 6:08 PM CDT

EDIT:

Content:

Our client sent us a few pictures of the existing masks being used during testing. This helps us better gauge how high the mask covers the nose and where the glasses would have to fit on the mask.





10/8/21 - Client Meeting

RACHEL KRUEGER - Oct 08, 2021, 12:13 PM CDT

Title: Client Meeting

Date: 10/8/2021

Content by: Rachel Krueger

Present: All group members

Goals: Update client on progress and get feedback

Content:

Updated client on our research progress and progress in terms of 3D scanning.

3 main research focus areas: face shapes/mask materials, 3D printing/molding, equivalence testing

Will most likely be able to test our design using the VO2 testing system - Grace will talk to Staci regarding protocols.

Will try to get a list of previous materials used for us to use as a reference.

Conclusions/action items:

We won't be able to meet next week due to presentations, but continue to update client and ask questions as needed.

10/29/21 Client Meeting

RACHEL KRUEGER - Oct 29, 2021, 12:11 PM CDT

Title: Client Meeting

Date: 10/29/2021

Content by: Rachel Krueger

Present: All but Thomas and Victoria - valid conflicts

Goals: Inform client about changes to project.

Content:

Discussed design changes, fabrication, and changes.

They agreed with the design changes and are looking forward to more progress.

Hope to get pieces printed in the next week to do some basic functional testing and make any necessary changes after that.

Meet again in two weeks due to show and tell conflict.

Conclusions/action items:

Finish CAD of the plastic pieces, get printed, functional testing.

11/19/21 Client Meeting

RACHEL KRUEGER - Nov 19, 2021, 12:10 PM CST

Title: Client Meeting

Date: 11/19/2021

Content by: Rachel Krueger

Present: Grace, all team members

Goals: Update client on progress and next steps.

Content:

- updated client on the progress with extension piece, plan on printing before thanksgiving

-talked about testing protocol

- adrienne explained extension piece cad model

- jakob showed how the extension piece would attach

Conclusions/action items:

-get piece printed and make necessary changes depending on fit and comfort.

12/3/21 Client Meeting

THOMAS KRIEWALDT - Dec 03, 2021, 12:27 PM CST

Title: Client Meeting

Date: 12/3/2021

Content by: Thomas Kriewaldt

Present: All team members

Goals: To share our recent progress on the mask

Content:

We met with Staci and Grace today to discuss what we got done in the last two weeks. The last time we met was before our initial print, so we went through our two design iterations with them today. They seemed satisfied with a picture of our design.

We also discussed testing that we will be doing this weekend. The testing outline was not previously shared with them, so Rachel sent them an email and the team explained how we would be conducting our testing. They liked the idea of using a few different machines for each team member participating in the testing procedure, and Staci suggested that we should take videos of the masks while in use to capture movement (if there is any). We also can then play these videos during our presentation.

Lastly, Staci stated that she would not be able to attend on Friday, but someone from Johnson Health Tech would be there to view the project.

Conclusions/action items:

Undergo the testing procedure, gather results, and draw conclusions from observations

9/17/21 - First Advisor Meeting

VICTORIA HEILIGENTHAL - Sep 17, 2021, 8:11 PM CDT

Title: First Advisor Meeting

Date: 9/17/21

Content by: Victoria

Present: Victoria, Rachel, Jakob, Sinan, Adrienne, Tommy

Goals: To introduce ourselves to our advisors and to learn about their expectations of us

Content:

- Introductions
  - Name, specialization tract, year, why we chose the project
- Advisors talked about their own experiences within the fields they worked in
  - Informed us about opportunities through networking with them
- Went through course schedule and calendar to discuss important due dates and deadlines
  - Need to double check that the PDS is due next week and not in 2 weeks
- Both advisors (James Trevathan and Kip Ludwig) suggested that we look at the evaluation forms for each major assignment in regards to our project
  - See what main points we need to hit and what they will be grading on the hardest
- We will meet again next week to discuss more progress we've made

Conclusions/action items: Be prepared for our next advisor meeting to discuss the progress we have made so far in the project and to bring any questions we have for them to the meeting.

9/24/21 - Advisor Meeting

RACHEL KRUEGER - Sep 24, 2021, 12:58 PM CDT

Title: Advisor Meeting

Date: 9/24/2021

Content by: Rachel Krueger

Present: All group members and advisors

Goals: Go over progress and upcoming dates with our advisors.

Content:

1. Mid semester and final grades for the course are weighted differently, but equivalent number of points associated with it. About .75/.25 final/mid.
2. If you're doing well at mid semester, you're doing everything right so make sure you keep that up because end of semester grades are weighted much heavier.
3. You are going to have to do peer reviews - have to give points to other team members and to yourself and total points have to add up to 6000 points.
4. Put the order of team members in peer reviews in the same order that is on the team website.
5. Coming up: PDS is due today by the end of the day and make sure we put on website. For next week: design matrix is due. Neither of these are graded independently. First graded assignment is the design deliverables oral presentation.
6. Lab notebook grades have a grade sheet under evaluation forms. Biggest mistake - lab notebook grades are individual, not by team. Everyone should have some aspect of each thing on the rubric in their notebook. Even if things don't pertain to the project, put a little snippet that shows you considered it.
7. Very important how we define our specifications and how we quantify them in the PDS. Worth thinking about early on. Set reasonable expectations for the semester in terms of credit hours, feasibility, etc. Make sure your metrics are actually quantifiable.
8. Need to think about the statistics we want to do before we do the experiments to make sure it gives meaningful results.
9. For the week before oral presentations, should send the slides to advisors before for feedback.

Conclusions/action items:

Finalize and submit PDS. Work on design matrix with team and choose the design we want to move forward with.

10/1/21 - Advisor Meeting

RACHEL KRUEGER - Oct 01, 2021, 12:56 PM CDT

Title: Advisor Meeting

Date: 10/1/2021

Content by: Rachel Krueger

Present: All team members

Goals: Get feedback from advisor on design matrix.

Content:

PDS presentation delayed a week - in person presentation

qualitative and quantitative results that compare the results from original mask and the fit of the mask

goal is to think about how we can quantify equivalency - with and without glasses, with previous mask and our mask

Very important how we quantify the results at the end.

Need to add that into PDS more.

for accuracy and reliability - looking for us to describe where these numbers come from - is it a clinical measurement? how is it meaningful?

Feedback on designs: good designs, can definitely consider combining design 1&2. Can always change the design after deciding on one and its not working the way we want it to.

make sure we don't perform incorrect statistics for this device and project.

Conclusions/action items:

10/8/21 - Advisor Meeting

VICTORIA HEILIGENTHAL - Oct 08, 2021, 12:44 PM CDT

Title: Advisor Meeting

Date: 10/8/21

Content by: Victoria

Present:

Goals: To discuss what the team has done this week and any concerns from the advisor

Content:

- Oral presentations next week in person
    - 10 minute presentation-2 minutes each
    - Most teams struggle to hit goal of presentation
    - Look at grading rubric
    - Make sure have title or label for each item on list (make sure hit everything)
    - Can send to advisors beforehand to check

Conclusions/action items: The team should continue to dive into the areas we had discussed for researching so we can start looking into our Preliminary Design Presentations

10/22/21 - Advisor Meeting

THOMAS KRIEWALDT - Oct 22, 2021, 12:55 PM CDT

Title: Advisor Meeting

Date: 10/22/21

Content by: Tommy Kriewaldt

Present: All members

Goals: To discuss what the team has done this week and any concerns from the advisors.

Content:

We discussed some aspects of equivalency testing.

- Concerns on what to choose for equivalency margin..
- It depends, could compare to previous tests, other third party tests, or even the accuracy of the VO2 machine running the test. WE CHOOSE!
    - If it falls into these ranges, we must justify it somehow.. Make sure to check with advisors and clients after the test to make sure we conducted it correctly and in the manner that they would want it to be in.
    - Testing usually has about a 3% error, so if it in this margin, we should be good to say that the equivalence test was successful.

We should be at the point where we are almost done prototyping, and thinking about how we will test our project.

- November 5 is the next deliverable, it is not graded, but rather an opportunity to get feedback from other students.
    - Lay out the plan for fabrication and testing, and show any prototypes for feedback if applicable.
- Second week of December, NEXT BIG DEADLINE!!
    - Do our testing, materials ordering, 3D printing, as well as other fabrication methods WELL BEFORE this date, so we don't have a backlog of work.

We also discussed materials for 3D Printing at the MakerSpace

- We want to print using elastic materials at the MakerSpace, but we are not sure which one specifically quite yet
- A worker at the MakerSpace will help us figure out the specifics of the materials when we go to 3D print our first prototype
- Consider the gaps in the silicone-like materials as well, air leakage is important to not have in our product
    - Maybe use a FDM printer or FormLabs printer.. ask a MakerSpace employee
    - Maybe consider printing a mold and then molding the silicone mask that way.. FormLabs has good instructions for fabrication in this method.

Conclusions/action items:

10/29/21 - Advisor Meeting

RACHEL KRUEGER - Oct 29, 2021, 12:45 PM CDT

Title: Advisor Meeting

Date: 10/29/2021

Content by: Rachel Krueger

Present: All but Jakob and Victoria - valid excuses

Goals: Update advisor on changes

Content:

Monday will get grades back - will show up on canvas

Show and tell: in person. Not sure where yet.

James is perfectly fine with the direction we are going in.

James explained the logistics of show and tell - reference document on website for clarification

Conclusions/action items:

Continue prototyping and prepare for show and tell

11/12/21 - Advisor Meeting

RACHEL KRUEGER - Nov 12, 2021, 12:56 PM CST

Title: Advisor Meeting

Date: 11/12/2021

Content by: Rachel Krueger

Present: Adrienne, Jakob, Rachel

Goals: Update James on progress and difficulties.

Content:

- use meshlabs to simplify the stl file so solidworks lets us edit the piece

- start to lay out testing plans

- highly recommends meshlabs to do basic editing

- use the 3D printed piece to get a better idea of dimensions we want to use for the extension piece

- discussed feedback on grades and where we are in the semester

- discussed future plans

- james is going to ask around about possible resources that can help us with solidworks modeling

Conclusions/action items:

- use meshlabs to try to get an stl file that is able to be edited

- stop by makerspace for help and advice

- for rest of semester: prototype working, quantifiable data and analysis of results.

- how you analyze data and results is what advisors will be looking for

- need to show an effort to get some sort of data, even if something comes up and we can't get the data we were intending to collect

12/3/21 - Advisor Meeting

JAKOB KNAUSS - Dec 13, 2021, 4:03 PM CST

Title: Advisor Meeting

Date: 12/4/2021

Content by: Jakob Knauss

Present: entire team

Goals: Update James on progress and difficulties.

Content:

- discussed progress: completed physical prototype, plan for testing, in a good spot

- find statistical test that is appropriate for analyzing discrete survey data like we are planning to obtain

- explain restraints in terms of sample size and bias in presentation and report

- let him know if we run into any last minute issues

- discussed poster presentation logistics

Conclusions/action items:

- conduct functional testing this weekend (12/5) according to testing protocol

- analyze data and form conclusions

- prepare poster presentation and final report

9/10/21 - Initial Team Meeting

THOMAS KRIEWALDT - Oct 19, 2021, 6:11 PM CDT

Title: Team Meeting

Date: 9/10/21

Content by: Thomas Kriewaldt

Present: All team members

Goals: To assign team roles and discuss initial research topics.

Content:

We assigned team roles as follows:

Team Leader: Victoria Heiligenthal

Communicator: Rachel Krueger

BSAC: Jakob Knauss

BPAG: Sinan Ozturk

Co-BWIG: Adrienne Rasmussen

Co-BWIG: Tommy Kriewaldt

Conclusions/action items:

We will meet again soon as a team to discuss our preliminary research and design ideas.

9/17/21 - Team Meeting

THOMAS KRIEWALDT - Oct 19, 2021, 8:16 PM CDT

Title: Team Meeting

Date: 9/17/21

Content by: Tommy Kriewaldt

Present: All team members

Goals: To discuss our PDS draft and preliminary design sketches

Content:

Today we discussed how we would go about our first assignment, our Product Design Statement. This is due in a week, so we should be prepared to deliver a finished, concise product to our clients and advisors.

Our team leader, Victoria, had already created the outlined document for the PDS, so we discussed some its sections in today's meeting. There were a few portions of the required document we were not familiar with, so we have decided to research further and divide these sections to the people conducting the specific research.

Specifically, we are not familiar with some of the testing methods, ergonomics or materials we will be using during this project. We should research these sections further to be experts on our own project before we submit our PDS. Also, we have come to the conclusion that we should start to lay out some early design ideas using pencil and paper, which we will do on our individual accord and then discuss as a team during a meeting next week.

Lastly, we completed our client's requirements from the information on the project page during this meeting.

Conclusions/action items:

Team members should conduct research on these unfamiliar aspects of our design, and also write these sections in the PDS, as they will have the best knowledge on the section. We will meet again next week to discuss final edits to our PDS, as well as preliminary sketches we came up with between the meetings.

9/29/21 - Team Meeting

THOMAS KRIEWALDT - Oct 19, 2021, 9:00 PM CDT

Title: Team Meeting

Date: 9/29/2021

Content by: Tommy Kriewaldt

Present: All team members

Goals: To develop an adequate design matrix, to gain rough idea of our project's design moving forward, and to discuss further research on specific aspects of our design.

Content:

Our team met in person to discuss our goals outlined above.

We started by discussing some of our own ideas, through sketches, discussion and physical analyzation of a VO2 mask. We narrowed it down to three designs: the Clips and Lower Bridge design, the Divot design, and the Nose Clip design. Of these, we chose the Clips and Lower Bridge design, as it was evaluated the highest of the three designs in our table.

At this point in time, we don't have a final sketch for this design, but we plan to fabricate it using a silicone mold, similar to the standard mask Johnson Health Tech lended us as a reference for this design. We will lower the nose bridge and add small clips to the side of our mask to ensure that the glasses are able to fit on the nose bridge, as well as stay secure on the face while the mask is in use.

Comfort, Accuracy, and Durability were our main design matrix criterion, because our team felt that these were the most important aspects of our design, with respect to our client's needs. We felt that the Clips and Lower Bridge design was the most adequate of the three design ideas in all three of these areas. This design is comfortable, shouldn't affect VO2 max testing results and should not be able to be deformed easily when it is under pressure. The other design criteria we felt was important, but not as much as the top three we chose.

We also discussed a few other potential challenges with this design. We want to make this design suitable for all sizes of eyeglasses so we should make our clips and the height of the silicon on the nose bridge reflect this. Our team also discussed potential materials, like silicone, that we want to use to construct our product. We should research silicone and other similar materials and see how we can fabricate our design idea.

Conclusions/action items:

We chose the "Clips and Lower Bridge" design because it scored the highest in our design matrix. This is subject to change with small modifications, but this is the design we will be sticking with moving forward. We should research into fabrication techniques and discuss our findings with our client when we meet with them on Friday.

10/9/21 - Team Meeting

THOMAS KRIEWALDT - Oct 19, 2021, 9:00 PM CDT

Title: Team Meeting

Date: 10/9/21

Content by: Tommy Kriewaldt

Present: All team members

Goals: Discuss prior research each team member conducted, and assign slides to team members for the preliminary presentation

Content:

We met to discuss our individual research. We researched various aspects of our topic, including: silicone materials, silicone fabrication techniques, MakerSpace materials similar to silicone, other competing designs, as well as equivalence testing. Each team member shared their research with all of the other members.

We also assigned slides to team members. The order we chose is: Adrienne, Tommy, Sinan, Rachel, Jakob, then Victoria, with all of us covering at least two slides or topics. We all plan to work on our slides through the beginning of this week then meet again before the presentation to make sure everyone's slides cover what they need to and that we meet the required time limit of ten minutes, specified on the rubric.

Also, Sinan was able to create more detailed sketches of our design matrix ideas to use in our presentation.

Conclusions/action items:

We assigned roles to specific slides on the preliminary presentation. Our team will meet to rehearse on Wednesday or Thursday to rehearse before the physical presentation.

10/14/21 - Team Meeting

THOMAS KRIEWALDT - Oct 19, 2021, 5:57 PM CDT

Title: Team Meeting

Date: 10/14/21

Content by: Tommy Kriewaldt

Present: All team members

Goals: To rehearse and make final edits on our preliminary presentation.

Content:

We didn't discuss much in today's meeting, besides our team's preliminary presentation. We met as a team previously to work on the team's slides and additional background research for this deadline, but today's meeting focused more on final edits and rehearsal of an already finished document.

We ran through the presentation two times, with both being over the allotted time of ten minutes. The first was well over the limit, as it was timed at over twelve and a half minutes. With some refining though, the second trial was just above ten and a minutes.

In addition to these rehearsals, we also made sure to fix our sources, as they were not cited properly in IEEE format, and also to add figure numbers to the pictures, charts, and drawings found in our slides document.

Lastly, our team leader, Victoria mentioned that she would be gone for the presentation. She will be uploading her portion of the presentation beforehand so we can play it during the physical presentation.

Conclusions/action items:

Our team believes that with some more practice on each member's sections, we can deliver an adequate speech. We all will rehearse more tonight.

10/18/21 - Team Meeting

THOMAS KRIEWALDT - Oct 19, 2021, 6:26 PM CDT

Title: Team Meeting

Date: 10/18/21

Content by: Tommy Kriewaldt

Present: All team members but Rachel

Goals: To work on and discuss our team's upcoming preliminary design report, as well as future fabrication methods.

Content:

Our team met virtually to discuss how we would finish our preliminary design report.

Our team leader, Victoria, started by creating the document, shared with us in google drive. We worked on a few sections beforehand, so we started this meeting by going over these sections. We then divided up sections to start work on and peer review before submitting. We decided that splitting up some of the initial work for this long document would help us complete this report more efficiently.

- This is because many of our team members have conducted in-depth research on specific areas of our design. By dividing up this document initially, it allows the team member with the most knowledge about background or design processes for this project to work on that area first, then others can review and edit these areas.

Also, we had a very brief discussion about materials in our design, specifically the material of the clips attachment. We decided on a standard alligator clip-type design using soft plastic, to ensure nothing breaks the user's glasses, but this is subject to change.

Conclusions/action items:

This document is not complete, but the team will work together to finish each section, with figures, pictures, and references throughout. Then, we plan to make final changes and edits together as a team the night before it is due, to ensure we have covered all of the topics we need to (in background, design process, etc.).

10/26/21 - Team Meeting

THOMAS KRIEWALDT - Oct 26, 2021, 6:32 PM CDT

Title: Team Meeting

Date: 10/26/21

Content by: Tommy Kriewaldt

Present: All members

Goals: To discuss our major design changes and new ideas.

Content:

We researched into different plastic (as well as other) materials that could possibly help us attach the mask to the glasses.

We have come to the realization that without internal changes to the mask or lowering the top dimensions, that the glasses will be sitting very far away from the user's face. It might be difficult to use our design idea, bridge and nose clips, then because the user would not be able to see very efficiently with the glasses being farther away..

There is some room for the glasses to fit in front of the glasses, but a clip might damage the nose bridge in use. We should let it sit comfortably on the front of the mask, but be clamped in by clips on the side of the glasses..

We should build an extension or extrusion off of the mask which goes near the ears at one set length. Velcro will be attached to the end and then hold the glasses in place, securely. This attachment would work for each size of mask. We will likely just stick to using PLA plastic to print these clips, as they would be most similar to the clips on the current mask design.

We should be prepared to make a mask if we need to, as its possible for the glasses to not fit comfortably on the mask when we undergo testing. Victoria is looking into the materials, like velcro, we need to buy, but we should be prepared for any outcome or adjustments based on our testing.

Conclusions/action items:

Create a SolidWorks or AutoCAD model of the top two clip attachments by the end of the week, so we can 3D print by this weekend.

11/29/21 - Team Meeting

THOMAS KRIEWALDT - Dec 02, 2021, 9:27 PM CST

Title: Team Meeting

Date: 11/29/21

Content by: Tommy Kriewaldt

Present: All members

Goals: To discuss future goals and some of the work done over Thanksgiving Break.

Content:

Our team discussed what we all did over break as well as some future work that we have to do.

The first thing was that the 3D printed clip attachments were sanded down, to ensure user safety and a frictionless attachment to the plastic piece. Once the pieces were sanded down, a hole was drilled into our soft plastic clip piece, near the holes for the straps and attachment to the mask. Specifically, a 1/4" hole was drilled and deemed to be the best fit. Then, the sanded pieces were fit into these holes and fit nearly perfectly. Some pictures are below of one member wearing the mask. We decided to adjust the plastic pieces to be a little bit shorter, to try and reduce how much of the plastic pieces are visible while wearing the mask. We should have these printed by the end of the week.

Next, we talked about what work we had to complete this week. We didn't decide to divide up the work, but the team discussed that our final report, PDS, and presentation slides should be done throughout the week, and finish them when we do testing this weekend.

Conclusions/action items:

To print new plastic pieces, sand them and undergo testing before the end of this week. Then we should complete the aforementioned documents.

12/4/21 - Functional Testing

JAKOB KNAUSS - Dec 13, 2021, 4:15 PM CST

Title: Functional Testing

Date: 12/4/21

Content by: Jakob Knauss

Present: All members except Tommy (sick)

Goals: To complete functional testing, obtain survey data, and observe ability of our design during activity.

Content:

The team gathered at the Nicholas Recreation Center on campus to perform functional testing of our design compared to the existing mask. Four team members participated in the testing. For details on how the test was run, the testing outline is attached. Survey data was collected on a five-point scale as to compare ratings between the existing mask and the mask with our extension pieces attached. The results will be analyzed to the extent possible given the small sample size. Overall, testing went smoothly. Some photos and videos are also attached.

Conclusions/action items:

To analyze the data collected during testing and form conclusions. Explain our results in the final poster presentation and final report.

Design Matrix - 9/28/21

VICTORIA HEILIGENTHAL - Sep 28, 2021, 8:41 PM CDT

Title: Design Matrix Meeting

Date: 9/28/21

Content by: Victoria

Present: All members

Goals: To finalize our design matrix and to get a better understanding of what our final design might be

Content:

Prior to this team meeting, each team member brainstormed at least two design ideas that they could share to the group for design matrix considerations. It had seemed like we all had pretty similar design ideas, so we focused on the overlapping ideas and then merged some pieces of different designs together. We then settled on three different designs based on the criteria we thought would be most important to consider. Below is the 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	
Total	100		79		69		48

Comfort and accuracy were weighted the highest because the subject should be as comfortable as possible during testing with their glasses, but accurate data and results should also not comprise this. Durability was weighted next highest because the masks will undergo multiple rounds of testing with different subjects, so it needs to withstand those tests at the conditions they are done at. The ease of use of the product was weighted next highest because it shouldn't be complicated for the subject to wear their glasses and the mask. Safety and cost were weighted the least because all the designs were safe and would all stay within the budget provided by the client. In the end, the design that incorporates the clips and lowers the bridge of the nose scored the highest and is most likely going to be the design the team targets for this semester.

Conclusions/action items: Brainstorming these ideas was good to figure out where we wanted to go from here. Now, we have a better understanding of what our design is going to look like for the semester.

Handdrawn Sketches of Designs - 10/17/21

VICTORIA HEILIGENTHAL - Oct 19, 2021, 7:54 AM CDT

Title: Hand drawn Sketches of Designs

Date: 10/17/21

Content by: Victoria

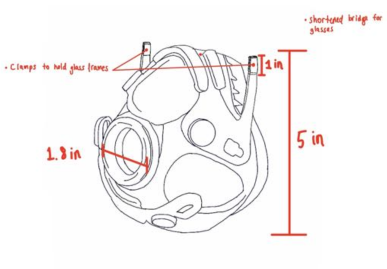
Present: N/A

Goals: To document and better display the designs brainstormed by the team

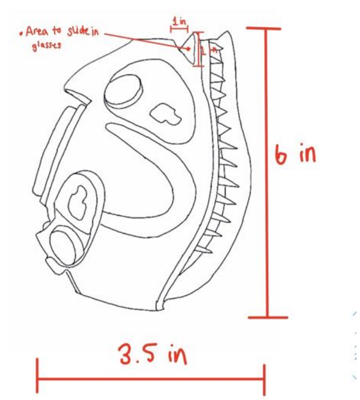
Content:

All images were drawn by Sinan

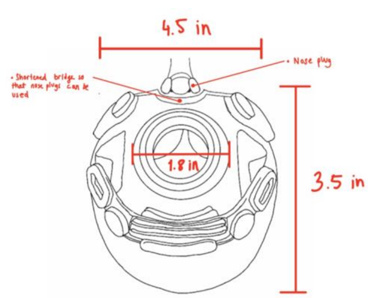
-Clamps and lower bridge design



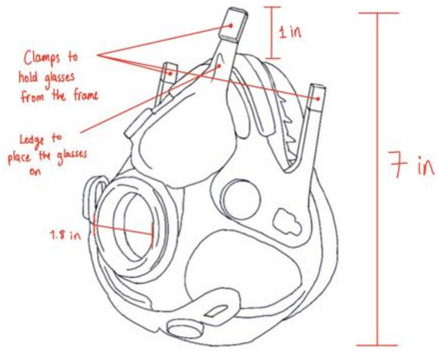
-Divot design



-Nose clip design



-Final design (clamps on side and front of mask to hold glasses)



Conclusions/action items: These sketches help show a better picture of what the team is going to be fabricating this semester.

Materials at Makerspace - 10/6/21

VICTORIA HEILIGENTHAL - Oct 19, 2021, 7:55 AM CDT

Title: Materials at Makerspace

Date: 10/6/21

Content by: Victoria Heiligenthal

Present: N/A

Goals: To document the materials available at the Makerspace to print

Content:

Since we are most likely going to be 3D printing our mask at the Makerspace, it is important to know what materials they have available so we can choose the best one when we 3D print our model.

Materials can be found: 3D Printers – UW Makerspace – UW–Madison (wisc.edu)

Will need something most similar to silicone and rubber like how the current masks are

- This link is from Formlabs: Find the Right 3D Printing Material for Your Application (formlabs.com)
    - According to the website, Elastic and Flexible Formlabs material would be best
    - Soft and stretchy material
    - Elastic-bend, stretch, compress, durable
    - Flexible-stiff soft touch, softness and strength, same as above
- We can always ask people at the MakerSpace what they recommend as well

Search: material most similar to silicon to 3d print, 3D Print Rubber - 3D Printing Gaskets - Rubber 3D Printing (rapidmade.com)

- Thermoplastic polyuethrane
- thermoplastic elastomer

Conclusions/action items: It is important to know what materials will be best for 3D printing the majority of the mask design. Depending on which design we go with for the final design, some additional or alternative materials might need to be considered.

New Clip Design Idea-10/28/21

VICTORIA HEILIGENTHAL - Oct 31, 2021, 9:34 PM CDT

Title: Clip design apparatus final design

Date: 10/28/21

Content by: Victoria

Present: N/A

Goals: To document and finalize the clip portion of the mask

Content:

Prior to meeting, the team had decided on using clips on the side of the mask to attach to the legs of the glasses to hold them in place during testing. Originally, the team was going to reprint the entire mask and add the clip piece to the 3D print, but we realized that the small plastic pieces in the front of the original mask are removable on the mask. We thought it would be easiest if we could reprint the plastic pieces to accommodate for glasses users that can be easily added or removed from the mask depending on the subject of the test. This would also lower the potential risk for errors and leakage of the mask if a new mask was printed. The 3D CAD sketch of the new mask also might not be as identical and similar to the original mask as we want it to be. So, reprinting the plastic pieces with our design will be more cost efficient for the client, will be easier to manufacture for the client if multiple pieces want to be reprinted, and will allow for easy adjustments during testing for the client.

After brainstorming, the team has decided to add an extension piece to a plastic piece that will be able to snap into the front of the mask like the original plastic pieces. The extension piece will have a small slit in the front that will allow for a velcro strap to loop into. The velcro strap will then be used to wrap around the legs of the glasses and can be adjusted to the user's comfort. This design allows for the users to wear their glasses during testing as well as accommodating all face and glasses shapes/sizes. The pieces will most likely be plastic, but we will ask workers at the Makerspace what material would be most appropriate or most similar to the current pieces.

The only issue with the design the team is still facing is the fact that the bridge portion of the glasses will still be slightly elevated over the mask since no portion of the actual mask is being changed. However, we are hoping that the straps will hold the glasses in place enough so that the user can still see properly. We tried putting the mask on ourselves with our own glasses, and it still seemed like we would be able to see properly and having the straps would keep the glasses from moving. After printing the plastic pieces and doing initial testing just to see if they are going to work, we can determine if we need to make any adjustments to the front of the mask to account for the bridge portion of the glasses.

Conclusions/action items: Moving forward, the team is drafting CAD sketches to use for 3D printing. After having the physical prints, we can determine where to go from there; if we need to change the front of the mask for the bridge of the glasses or if we move forward with the design.

Velcro For Straps-10/31/21

VICTORIA HEILIGENTHAL - Oct 31, 2021, 9:33 PM CDT

Title: Velcro for Straps

Date: 10/31/21

Content by: Victoria

Present: N/A

Goals: To document the purchased velcro for the straps

Content:

This velcro will be cut into appropriate and correct strips to be inserted into a plastic piece on the mask, then wrap around the glasses to stay firmly on the user.

VELCRO® Brand ONE WRAP® Fastener | HookandLoop.com

Purchased 1 roll: $27.17

Hook and Loop manufacturer

Conclusions/action items: Once the Velcro comes in, the team can fully asses if the straps will be functional

Plastic Piece Dimensions-10/31/21

VICTORIA HEILIGENTHAL - Oct 31, 2021, 10:11 PM CDT

Title: Plastic Piece Dimensions

Date: 10/31/21

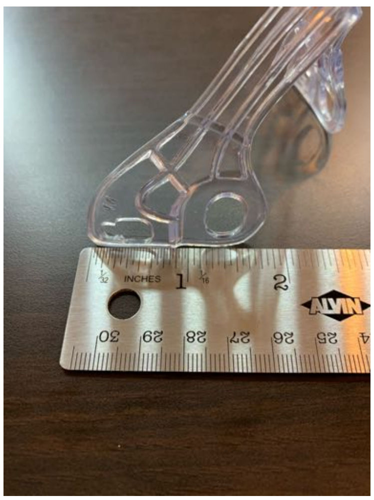
Content by: Victoria

Present: N/A

Goals: To document the dimensions of the current plastic piece from the mask

Content:

Side that attaches to mask: 2.875 in

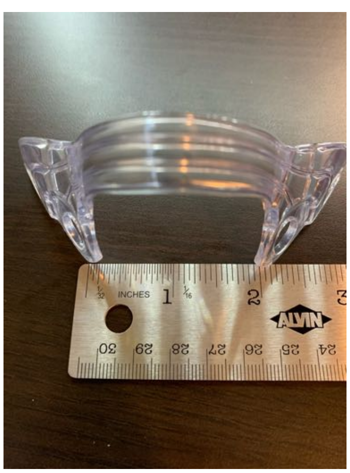


Width of piece: 4.125 in

Bridge of piece to end: 3.125 in

Diameter: 1.75 in

Distance between legs: 2 in



Conclusions/action items: These dimensions can be used for CAD sketches

Final Cost of Design-12/6/21

VICTORIA HEILIGENTHAL - Dec 06, 2021, 4:00 PM CST

Title: Final Cost of Design

Date: 12/6/21

Content by: Victoria

Present: N/A

Goals: To document the payments made to design the model

Content:

Expenses

Item	Description	Manufacturer	Part Number	Date	QTY	Cost Each	Total	Link
Component 1								
Velcro Brand One-Wrap Tape	Color: Black Width: ⅜"	Velcro Brand	189754	10/31/2021	25	1.03	27.17	http://hookandloop.com/
Component 2								
Plastic Piece 3D Printing	Material: Resin Color: See through	Formlabs	N/A	11/11/2021	1	N/A	8.27	N/A
Component 3								
Makerspace Materials Fee	Access to 3D scanners and printers	N/A	N/A	11/05/2021	1	50.00	50.00	N/A
Component 4								
Extension Piece 3D Printing	Material: PLA Color: Red	Ultimaker	N/A	11/22/2021	4	N/A	0.64	N/A
Component 5								
Extension Piece 3D Printing 2.0	Material: PLA Color: Black	Ultimaker	N/A	12/1/2021	4	N/A	0.56	N/A
TOTAL:								**$86.64**

Conclusions/action items: This shows that the team was far under budget ($400) for designing the mask.

Complete list of all components and materials-12/6/21

VICTORIA HEILIGENTHAL - Dec 06, 2021, 3:57 PM CST

VICTORIA HEILIGENTHAL - Dec 06, 2021, 4:07 PM CST

Title: Complete list of all components and materials

Date: 12/6/21

Content by: Victoria Heiligenthal

Present: N/A

Goals: To document the complete list of materials used for all components of the mask

Content:

Things used in additional team design:

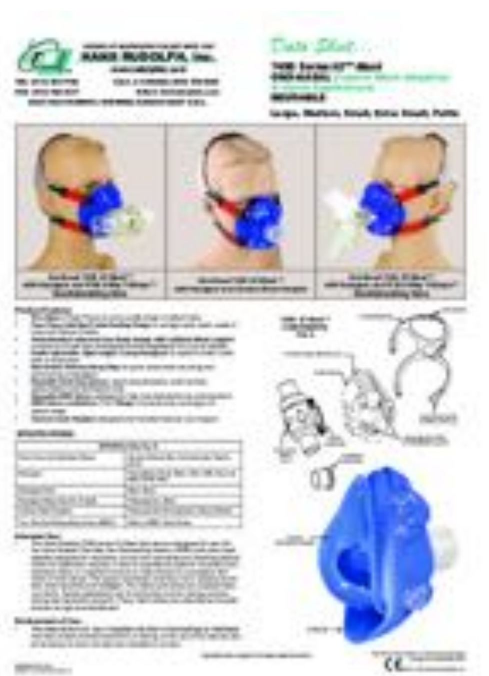
-Extension piece: PLA plastic (sturdy, tough plastic)
-Velcro strap (allow extension pieces to connect to legs of glasses securely)
-Structural top brace piece: resin (flexible plastic material that is similar to the current material used by the original mask)

Additional materials on mask that was not changed:
-Face piece: silicone rubber
-Headgear: polyurethane foam black, nylon UBL Gray and Nylon Fabric red
-Headgear hook: nylon
-Structural Brace piece: Polycarbonate Thermoplastic
-headgear strap clips: Polypropylene

The spec sheet of the mask manufacturer is also attached.

Conclusions/action items: The team can accurately explain how the mask was developed and the materials used for each component.

VICTORIA HEILIGENTHAL - Dec 06, 2021, 3:57 PM CST



face_mask_spec_sheet.pdf(1.5 MB) - download

Extension Piece-11/23/21

VICTORIA HEILIGENTHAL - Nov 23, 2021, 7:32 PM CST

Title: Extension Piece

Date: 11/23/21

Content by: Victoria

Present: N/A

Goals: To document the model of the extension piece

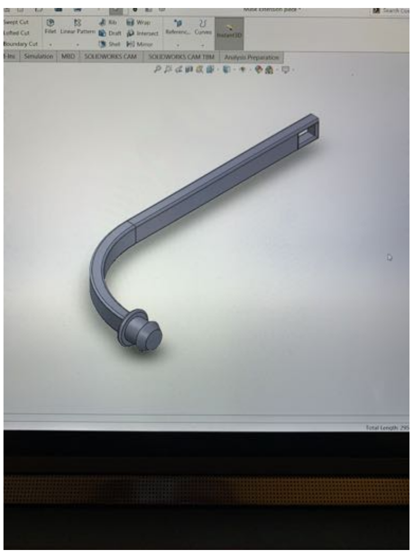
Content:

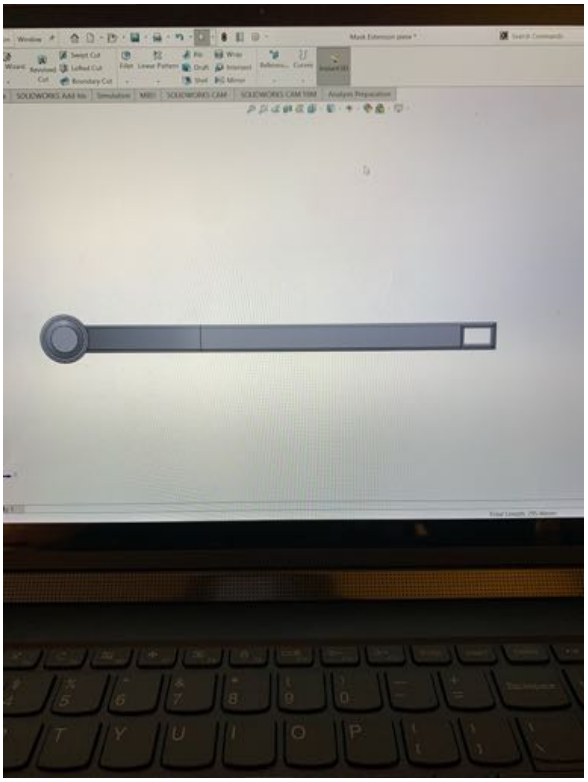
SolidWorks CAD Model:

-Shows slit where Velcro will be

-Shows angle turn to aim towards the user's glasses

-Shows how it will attach to the mask





Printed Version

Conclusions/action items: These pictures and models shows the extension piece. From here, the team can file down the piece to create a smoother finish and get ready for testing

Plastic Piece-11/23/21

VICTORIA HEILIGENTHAL - Nov 23, 2021, 7:33 PM CST

Title: Plastic piece

Date: 11/23/21

Content by: Victoria

Present: N/A

Goals: To document the plastic pieces from the mas

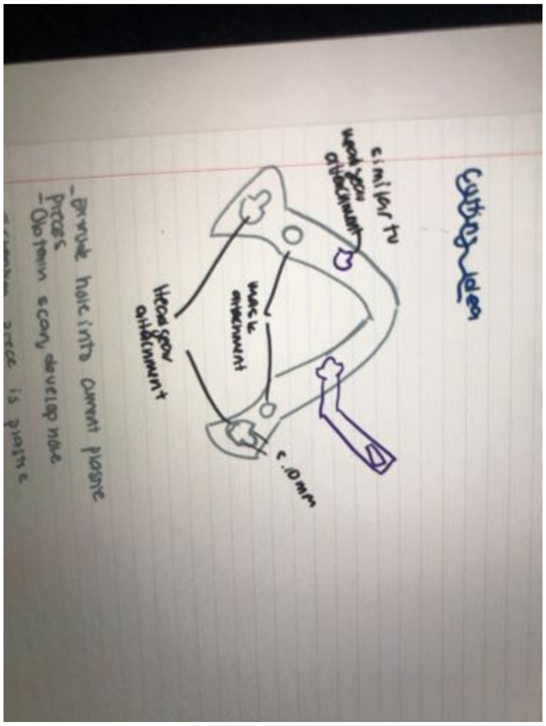
Content:

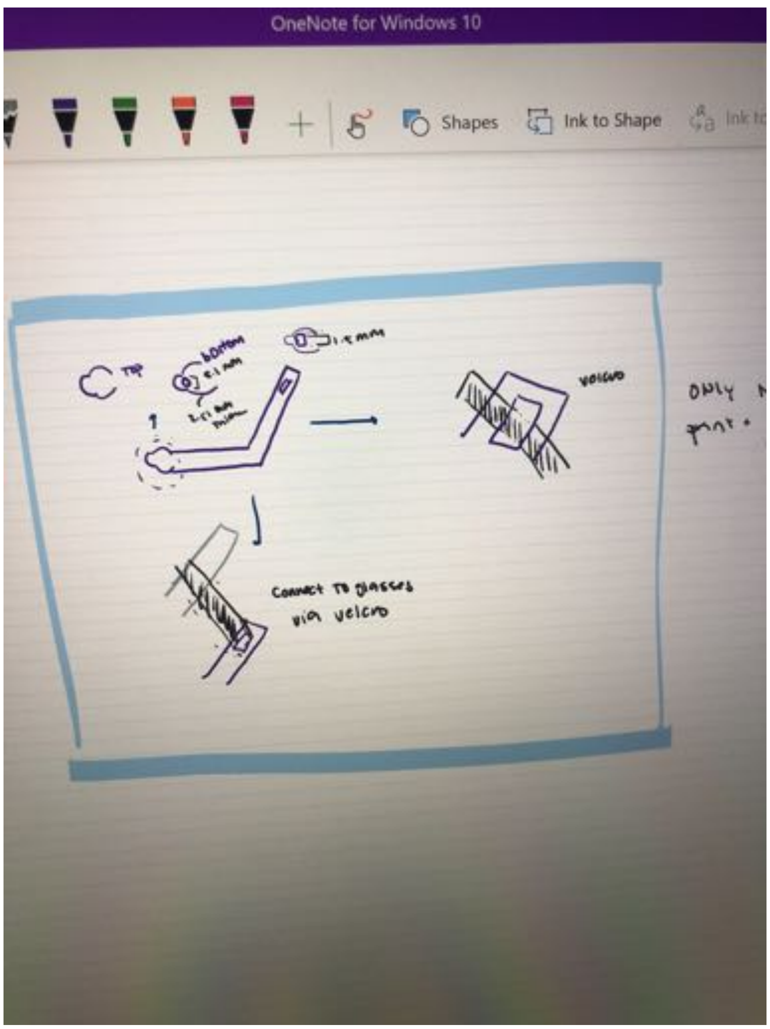
The team decided to 3D print the plastic piece from the mask from a 3D scan of the piece. This piece will allow the team to edit it and make changes rather than modifying the one on the mask from the client.

3D scanned model:

Inserted below

Sketches of plastic piece and extension piece:





Conclusions/action items: These images and files show the plastic piece of the mask for the final design

VICTORIA HEILIGENTHAL - Nov 23, 2021, 7:33 PM CST

,

Knauss_11_8_Medium.stl(119.2 MB) - download

VICTORIA HEILIGENTHAL - Nov 23, 2021, 7:33 PM CST

,

Knauss_11_8_Small.stl(119.2 MB) - download

Dimensions of extension piece-12/6/21

VICTORIA HEILIGENTHAL - Dec 06, 2021, 10:56 PM CST

Title: Dimensions of extension piece

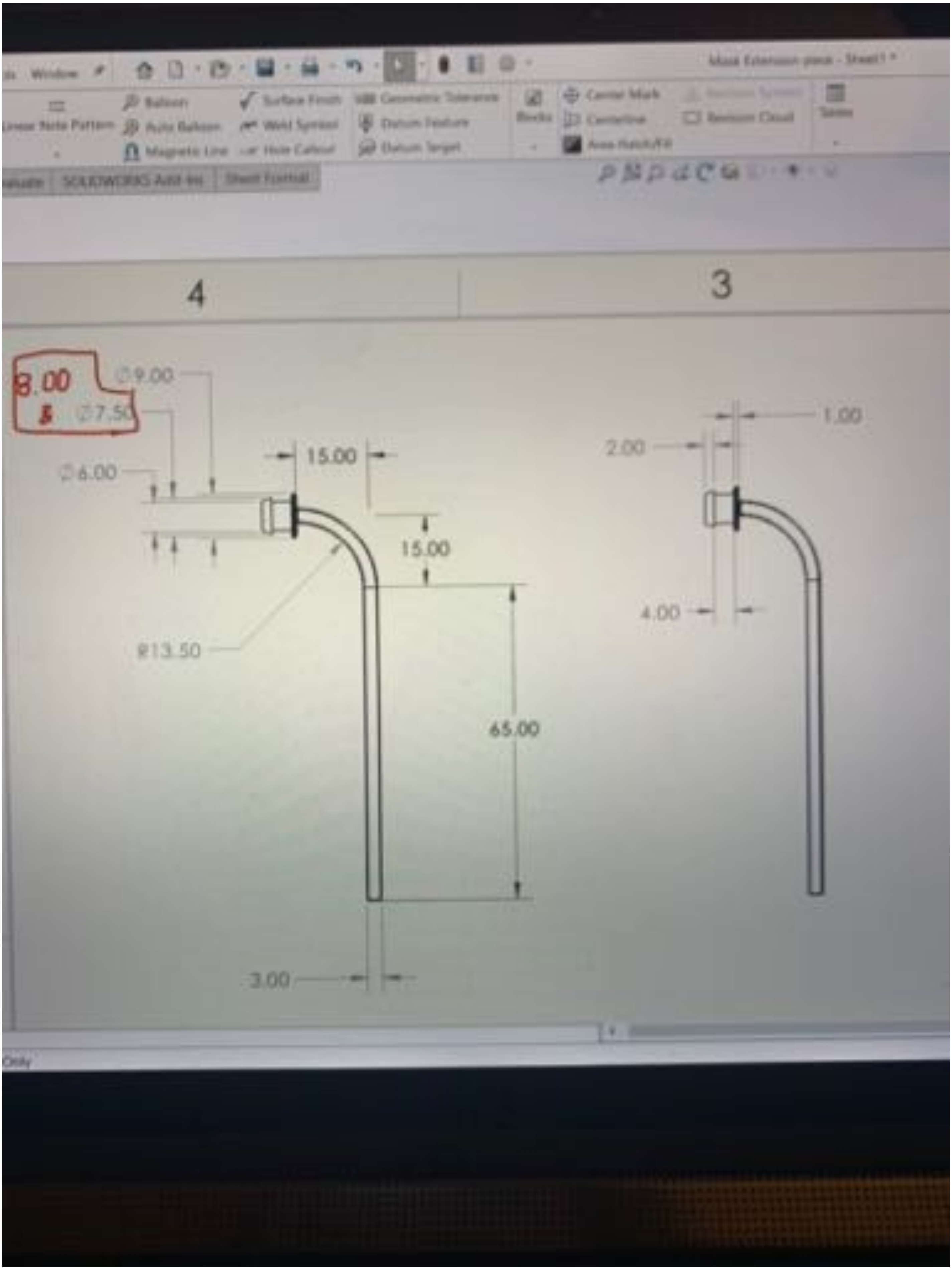
Date: 12/6/21

Content by: Victoria

Present: N/A

Goals: Document the dimensions of the extension piece

Content:



All dimensions in mm.

Two sizes were modeled, so the diameter of the insertion part of the piece was made with a 7.5- and 8-mm diameter.

Conclusions/action items: This image shows the dimensions of the extension piece modeled. The piece is universal for all users.

Pictures of final design12/6/21

VICTORIA HEILIGENTHAL - Dec 06, 2021, 10:56 PM CST

Title: Pictures of Final Design

Date: 12/6/21

Content by: Victoria

Present: N/A

Goals: Show how the final design turned out

Content:

Conclusions/action items: By showing these pictures, it will be easier for the team to explain and show how the design functions.

Johnson Health Tech Vo2 Mask, Procedures-9/22/21

VICTORIA HEILIGENTHAL - Nov 23, 2021, 7:39 PM CST

Title: JHT Current VO2 Mask and Protocols/Procedures

Date: 9/22/21

Content by: Victoria

Present: N/A

Goals: To show what the current mask model JHT uses so we can change it based on their needs. Also to document their procedures

Content:

Citation:

[1] J. H. Tech, "VO2 Instructional JHT," 2019.

[1] J. Muench, "Step+ VO2 Validation," 2018.

Attached to this entry are the protocols used by JHT during testing as well as the cleaning instructions for the mask.

Conclusions/action items:

These protocols can be used when we do reliability testing for our designs.

VICTORIA HEILIGENTHAL - Nov 23, 2021, 7:39 PM CST

VO2_Instructional_JHT.docx(1 MB) - download

JHT_testing_protocols.docx(89.8 KB) - download

VO2 Max standards, procedures, protocols-9/25/21

VICTORIA HEILIGENTHAL - Nov 23, 2021, 7:39 PM CST

Title: VO2 Max standards, procedures, protocols

Date: 9/25/21

Content by: Victoria

Present: N/A

Goals: To understand the protocols, procedures and standards for VO2 max testing

Content:

Protocols

Search: "treadmill test protocols" Google

Treadmill protocols for determination of maximum oxygen uptake in runners. (nih.gov)

Citation: T. R. McConnell and B. A. Clark, "Treadmill protocols for determination of maximum oxygen uptake in runners.," *Br J Sports Med*, vol. 22, no. 1, pp. 3–5, Mar. 1988.

Treadmill Stress Testing - StatPearls - NCBI Bookshelf (nih.gov)

Citation: V. Vilcant and R. Zeltser, "Treadmill Stress Testing," in *StatPearls*, Treasure Island (FL): StatPearls Publishing, 2021. Accessed: Sep. 25, 2021. [Online]. Available: http://www.ncbi.nlm.nih.gov/books/NBK499903/

- Use speed protocols
    - The study above used 4 test protocols
    - P1 and P2 were at same speed, but for different testing durations
    - P3 was tested at the mean pace of all subjects
    - P4 was tested at the speed the participants could choose on the treadmill
    - Important to use so can see the results at different testing levels and ensure the results are compatible with each other
- Bruce Protocol for Stress Testing
    - 3 minute stages
    - Walk at faster speeds each stage with an increase in incline as well
    - Can be adjusted based on tolerance for 6-12 minutes

Standards

Search: "vo2 max standards"

Aerobic fitness norms for males and females aged 6 to 75 years: a review - PubMed (nih.gov)

Citation: E. Shvartz and R. C. Reibold, "Aerobic fitness norms for males and females aged 6 to 75 years: a review," *Aviat Space Environ Med*, vol. 61, no. 1, pp. 3–11, Jan. 1990.

- This study found some mean norms and standard values for vo2 max testing across a wide range of ages and over both sexes
- Males
    - 1 L/min - 6 yrs, 12 L/min-12 yrs, 3.4 L/min-18 yrs
    - Decline to 3.2, 2.7, 1.6 L/min for 30, 50, 75 respectively
    - 47.5, 50, 48, 35, 25 for above age groups (ml/kg/min)
- Females
    - 0.9,1.8,2.2,1.8,1.1 L/min - 6, 12, 18, 30, 50 75 years
    - 42.5,44,41,2817.5 (ml/kg/min) for above age groups

- Shows that vo2 max peaks at a certain age, then drops

Procedures

- The procedures followed should be consistent with the ones documented and provided by JHT

Conclusions/action items:

Prior to testing, it is very important to lay out the standards, protocols and procedures so we can make sure our data is accurate and collected properly. We will also need to consider safety protocols for testing and for the mask.

New testing protocol-10/28/21

VICTORIA HEILIGENTHAL - Nov 23, 2021, 7:39 PM CST

Title: New Testing Procedure/Protocol

Date: 10/28/21

Content by: Victoria

Present: N/A

Goals: To outline the new type of testing the client has requested

Content:

After being in contact with the client after discussing the new direction we are heading in for our design, our client informed us of a new way of testing they wanted us to conduct. Rather than performing equivalence testing, the client said it would be appropriate for the team to conduct functional testing instead.

The client has suggested that for functional testing, we can test the mask on a treadmill for 2-3 different speeds, an Accent trainer (elliptical) and spin bike. We can test the clips/mask design on the pieces of equipment to ensure the mask is functioning properly and appropriately. It might still be important to ask for data previously collected from JHT for VO2 max tests using the previous mask to ensure our results are similar to their previous results. However, knowing this about the testing is important before we start outlining our testing procedure to collect data.

Conclusions/action items: Moving forward, the team can work on outlining testing procedures and protocols for when we

Testing Outline-11/23/21

VICTORIA HEILIGENTHAL - Nov 23, 2021, 7:40 PM CST

Title: Testing outline

Date: 11/23/21

Content by: Victoria

Present: N/A

Goals: To show the testing outline for the team's design

Content:

Since the client informed the team that functional testing should be done instead of equivalency testing, the team had to rethink the testing process. The testing outline attached below shows how the team will perform testing of the design to ensure the product meets the needs of the client.

https://docs.google.com/document/d/1Bq2pSYxMYMo2MBVukLRDebboMR8lWaqNTFIMWz3vLec/edit?usp=sharing

Conclusions/action items: With this testing outline, the team is prepared for testing and shows exactly what will be done during testing.

Final Results-12/5/21

VICTORIA HEILIGENTHAL - Dec 05, 2021, 8:05 PM CST

Title: Final Results

Date: 12/5/21

Content by: Victoria

Present: NA

Goals: To document the results from testing

Content:

Below is a link of the results and statistical analysis of testing.

https://docs.google.com/spreadsheets/d/1m0d7VfwkeEJnK_FPWkkBSrefZH5et50KWbg9Jy1qVXI/edit?usp=sharing

Conclusions/action items:

Now that we have the data, we can begin to analyze it to see if the mask meets the needs of the client.

Pictures and Videos from testing-12/5/21

VICTORIA HEILIGENTHAL - Dec 05, 2021, 10:40 PM CST

VICTORIA HEILIGENTHAL - Dec 05, 2021, 10:40 PM CST

Title: Pictures and Videos from testing

Date: 12/5/21

Content by: Victoria

Present: N/A

Goals: To show how testing was completed

Content:

Images with the mask and extension pieces

Videos with mask and extension pieces and without

-cannot attach here but we have them.

Conclusions/action items: By having this documentation, it is easy to explain and show how we completed testing

9/16/21 - Progress Report 1

THOMAS KRIEWALDT - Oct 19, 2021, 9:10 PM CDT

Title: Progress Report 1

Date: 9/10/21 - 9/16/21

Content by: All members

Present: N/A

Goals: Provide completed progress report

Content:

THOMAS KRIEWALDT - Oct 19, 2021, 9:06 PM CDT

VO2_Mask_Progress_Report-1.pdf(61.1 KB) - download

9/23/21 - Progress Report 2

THOMAS KRIEWALDT - Oct 19, 2021, 9:10 PM CDT

Title: Progress Report 2

Date: 9/17/21 - 9/23/21

Content by: All members

Present: N/A

Goals: Provide completed progress report

Content:

THOMAS KRIEWALDT - Oct 19, 2021, 9:10 PM CDT

VO2_Mask_Progress_Report-2.pdf(123.2 KB) - download

9/30/21 - Progress Report 3

THOMAS KRIEWALDT - Oct 19, 2021, 9:11 PM CDT

Title: Progress Report 3

Date: 9/24/21 - 9/30/21

Content by: All members

Present: N/A

Goals: Provide completed progress report

Content:

THOMAS KRIEWALDT - Oct 19, 2021, 9:11 PM CDT

VO2_Mask_Progress_Report-3.pdf(120.5 KB) - download

10/7/21 - Progress Report 4

THOMAS KRIEWALDT - Oct 19, 2021, 9:11 PM CDT

Title: Progress Report 4

Date: 10/1/21 - 10/7/21

Content by: All members

Present: N/A

Goals: Provide completed progress report

Content:

THOMAS KRIEWALDT - Oct 19, 2021, 9:11 PM CDT

VO2_Mask_Progress_Report_Oct1-Oct7.pdf(122.3 KB) - download

10/14/21 - Progress Report 5

THOMAS KRIEWALDT - Oct 19, 2021, 9:12 PM CDT

Title: Progress Report 5

Date: 10/8/21 - 10/14/21

Content by: All members

Present: N/A

Goals: Provide completed progress report

Content:

THOMAS KRIEWALDT - Oct 19, 2021, 9:12 PM CDT

VO2_Mask_Progress_Report-5.pdf(123.5 KB) - download

10/21/21-Progress Report 6

VICTORIA HEILIGENTHAL - Dec 11, 2021, 9:40 AM CST

Title: Progress Report 6

Date: 10/15/21 - 10/21/21

Content by: All members

Present: N/A

Goals: Provide completed progress report

Content:

VICTORIA HEILIGENTHAL - Dec 11, 2021, 9:39 AM CST

VO2_Mask_Progress_Report-6.pdf(123.4 KB) - download

10/28/21-Progress Report 7

VICTORIA HEILIGENTHAL - Dec 11, 2021, 9:42 AM CST

Title: Progress Report 7

Date: 10/22/21 - 10/28/21

Content by: All members

Present: N/A

Goals: Provide completed progress report

Content:

VICTORIA HEILIGENTHAL - Dec 11, 2021, 9:42 AM CST

VO2_Mask_Progress_Report_Oct22-Oct28_10640_.pdf(119.9 KB) - download

11/4/21-Progress Report 8

VICTORIA HEILIGENTHAL - Dec 11, 2021, 9:53 AM CST

Title: Progress Report 8

Date: 10/29/21-11/4/21

Content by: All members

Present: N/A

Goals: Provide completed progress report

Content:

VICTORIA HEILIGENTHAL - Dec 11, 2021, 9:49 AM CST

VO2_Mask_Progress_Report_Oct29-Nov4_8275_.pdf(124.7 KB) - download

11/11/21-Progress Report 9

VICTORIA HEILIGENTHAL - Dec 11, 2021, 9:50 AM CST

Title: Progress Report 9

Date: 11/5/21-11/11/21

Content by: All members

Present: N/A

Goals: Provide completed progress report

Content:

VICTORIA HEILIGENTHAL - Dec 11, 2021, 9:51 AM CST

VO2_Mask_Progress_Report_Nov5-Nov11_8627_.pdf(122.3 KB) - download

11/18/21- Progress Report 10

VICTORIA HEILIGENTHAL - Dec 11, 2021, 9:53 AM CST

Title: Progress Report 10

Date: 11/12/21 - 11/18/21

Content by: All members

Present: N/A

Goals: Provide completed progress report

Content:

VICTORIA HEILIGENTHAL - Dec 11, 2021, 9:53 AM CST

VO2_Mask_Progress_Report_Nov12-Nov18_8796_.pdf(123.5 KB) - download

11/25/21-Progress Report 11

VICTORIA HEILIGENTHAL - Dec 11, 2021, 9:54 AM CST

Title: Progress Report 11

Date: 11/19/21 - 11/25/21

Content by: All members

Present: N/A

Goals: Provide completed progress report

Content:

VICTORIA HEILIGENTHAL - Dec 11, 2021, 9:54 AM CST

VO2_Mask_Progress_Report_Nov19-Nov25_9169_.pdf(124.8 KB) - download

12/2/21-Progress Report 12

VICTORIA HEILIGENTHAL - Dec 11, 2021, 9:55 AM CST

Title: Progress Report 12

Date: 11/26/21 - 12/2/21

Content by: All members

Present: N/A

Goals: Provide completed progress report

Content:

VICTORIA HEILIGENTHAL - Dec 11, 2021, 9:56 AM CST

VO2_Mask_Progress_Report_Nov26-Dec2_9323_.pdf(124 KB) - download

12/9/21-Progess Report 13

VICTORIA HEILIGENTHAL - Dec 11, 2021, 9:57 AM CST

Title: Progress Report 13

Date: 12/3/21 - 12/9/21

Content by: All members

Present: N/A

Goals: Provide completed progress report

Content:

VICTORIA HEILIGENTHAL - Dec 11, 2021, 9:58 AM CST

VO2_Mask_Progress_Report_Dec3-Dec9_10227_.pdf(125.9 KB) - download

Product Design Specifications

JAKOB KNAUSS - Oct 20, 2021, 8:41 AM CDT

Title: Product Design Specification

Date: 9/24/21

Content by: All members

Present: N/A

Goals: To create a Problem Design Specification document to share with our advisors and client

Conclusions/action items: Refine our PDS as we progress further into our project

Content:

THOMAS KRIEWALDT - Oct 19, 2021, 9:15 PM CDT


WISCONSIN

VO2_Mask_PDS_Version1.pdf(334.3 KB) - download

Preliminary Presentation Slides

THOMAS KRIEWALDT - Oct 20, 2021, 10:57 AM CDT

Title: Preliminary Presentation Slides

Date: 10/15/21

Content by: All members

Present: N/A

Goals: To create an adequate and accurate presentation representing our project.

Conclusions/action items: Use our presentation slides to give a preliminary speech on our project, some background regarding our design, our design ideas etc.

Content:

THOMAS KRIEWALDT - Oct 19, 2021, 9:18 PM CDT

Preliminary_Presentation.pdf(1.7 MB) - download

Preliminary Report

VICTORIA HEILIGENTHAL - Dec 11, 2021, 10:05 AM CST

Title: Preliminary Report

Date: 12/11/21

Content by: All members

Present: N/A

Goals: To create an adequate and accurate preliminary report representing our project.

Conclusions/action items: Use this preliminary report to set up the rest of the semester

Content:

VICTORIA HEILIGENTHAL - Dec 11, 2021, 10:03 AM CST

Preliminary_Design_Report.pdf(1.2 MB) - download

Final Poster Presentation

VICTORIA HEILIGENTHAL - Dec 11, 2021, 10:04 AM CST

Title: Final Poster

Date: 12/11/21

Content by: All members

Present: N/A

Goals: To create an adequate and accurate final presentation showing the finishing design and summary of our project.

Conclusions/action items: Use this poster to display the progress we made throughout the semester

Content:

VICTORIA HEILIGENTHAL - Dec 11, 2021, 10:04 AM CST

BME_300_Poster_Presentation.pptx.pdf(1.3 MB) - download

Final Report

JAKOB KNAUSS - Dec 13, 2021, 4:22 PM CST

Title: Final Report

Date: 12/13/21

Content by: All members

Present: N/A

Goals: To complete the Final Report document detailing our progress on the project over the course of the semester

Conclusions/action items: Submit all final deliverables

Content:

VICTORIA HEILIGENTHAL - Dec 13, 2021, 6:20 PM CST

Final_Design_Report.pdf(11.8 MB) - download

Final/Updated PDS

JAKOB KNAUSS - Dec 13, 2021, 4:24 PM CST

Title: Product Design Specification

Date: 12/13/21

Content by: All members

Present: N/A

Goals: To create an updated Problem Design Specification document based on changes and new discoveries over the course of the semester

Conclusions/action items: Attach and reference PDS within Final Report

Content:

JAKOB KNAUSS - Dec 13, 2021, 4:20 PM CST

Final_PDS.pdf(343.7 KB) - download

General Vo2 Max Testing- (9/12/21)

VICTORIA HEILIGENTHAL - Sep 13, 2021, 9:46 AM CDT

Title: General Vo2 Max testing

Date: 9/12/21

Content by: Victoria

Present: N/A

Goals: To gain a basic understanding of what Vo2 max testing is and how its used

Content:

VO2 Max Testing | Exercise Physiology Core Laboratory (virginia.edu)

Citation:

"Vo2 Max Testing," *University of Virginia School of Medicine*. [Online]. Available: https://med.virginia.edu/exercise-physiology-core-laboratory/fitness-assessment-for-community-members/vo2-max-testing/. [Accessed: 13-Sep-2021].

Search: vo2 max testing, Google

- Vo2 max: max oxygen amount used during intense activity and exercise by an individual
  - Used to determine cardiovascular and aerobic fitness
  - Muscles need oxygen during aerobic exercise
  - More oxygen can use = large energy output
- Measuring/Testing
  - Mask is used to measure the volume and concentrations of air inhaled and exhaled
  - Endurance exercise (biking, running) is done until exhaustion and max effort
  - Heart rate can be found

Conclusions/action items:

This article gave me a brief, but useful understanding of how Vo2 testing is done and how it can be beneficial to athletes. I think continuing to research how it is done, understand the benefits better, as well as finding similar products is going to be important moving forward.

VICTORIA HEILIGENTHAL - Sep 13, 2021, 9:40 AM CDT

Screenshot_197_.png(1 MB) - download

Methods of Vo2 Max Testing-9/13/21

VICTORIA HEILIGENTHAL - Sep 13, 2021, 6:46 PM CDT

Title: Methods of Vo2 Max Testing

Date: 9/13/21

Content by: Victoria

Present: N/A

Goals: To understand how a Vo2 max test is carried out so we know the procedures and risks of the test.

Content:

https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjdybXCjf3yAhU1GVkFHUdUDD4QFnoECBUQAw&url=https%3A%2F%2Fccts.osu.edu%2Fsites%2Fdefault%2Ffiles%2Finline-files%2FProcedures_Risks-exercise_testing.pdf&usg=AOvVaw1wfpGKoI5ij7bYI43W3sXU

Search: Vo2 max testing methods, Google

Procedure:

1. Test will require participant to walk or jog until physically exhausted
2. First start with a paced walk and the speed and/or incline will increase every set number of time. Test finished when no longer can continue or researcher thinks you cannot continue.
3. Typically takes 8-12 minutes
4. Breathe into mouthpiece with nose gently pinched with a clip so only breathing is happening through mouth.
5. Exhaled air goes into tube connected to device that measures volume and conc. of oxygen and CO2
6. Blood pressure and ECGs will be taken

Risks

1. Abnormal blood pressure
2. Chest pain
3. Shortness of breath
4. Fainting
5. Disordered heart beats
6. heart attack

Conclusions/action items:

It is important to make sure that we understand how the testing takes place as well as the risks that come with testing when designing our mask. We should try to figure out the exact procedures and protocols Johnson Health Tech follows when testing participants.

VICTORIA HEILIGENTHAL - Sep 13, 2021, 6:46 PM CDT

Procedures_Risks-exercise_testing.pdf(90.3 KB) - download

Vo2 Max Study in Athletes-9/13/21

VICTORIA HEILIGENTHAL - Sep 13, 2021, 6:17 PM CDT

Title: Vo2 Max Study in Athletes

Date: 9/13/21

Content by: Victoria Heiligenthal

Present: N/A

Goals: Analyze a study done on athletes in different sports to compare their Vo2 max levels.

Content:

Aerobic capacity as an indicator in different kinds of sports - PubMed (nih.gov)

Search: "vo2 max test for athletes", PubMed

Citation:

G. Ranković *et al.*, "Aerobic Capacity as An Indicator in Different Kinds of Sports," *Bosnian Journal of Basic Medical Sciences*, vol. 10, no. 1, pp. 44–48, Feb. 2010, doi: 10.17305/bjbms.2010.2734.

Although this study does not have anything to do with a Vo2 mask on the market or information about Vo2 masks, I think it is a valuable study to understand how Vo2 max testing can be analyzed and utilized. In this case, athletes from different sports were tested to see the aerobic capacities within the sports, as well as between the sports.

Intro:

- Vo2 max is used to see how a person can utilize the maximum amount of oxygen they can uptake during aerobic activity
- Maximal oxygen uptake- "maximum amount of oxygen which the organism consumes per unit of time while performing the exercise of growing intensity, and which cannot be further increased with further rise of exercise intensity"
  - Standard for physical capacity
  - L or mL of oxygen/minute
- Body weight can affect capacity

Study

- 22 football players, 18 volleyball players, 26 non-athletes (control); all males
- 6 minute bike test at 150 W
  - Oxygen uptake was calculated ml/kg/min to include bodyweight
- Football had highest Vo2 max, followed by volleyball then non-athletes

Examinees	VO_2max/l/min	SD
Football players	4,25*#	0,27
Volleyball players	3,95*	0,18
Non-athletes	3,19#	0,21

TABLE 1. Mean VO_2 max values in the groups of athletes and non-athletes expressed in l/min

Data are presented as the mean ± SD.

* $p<0{,}001$ vs. non-athletes, # $p<0{,}001$ vs. volleyball players

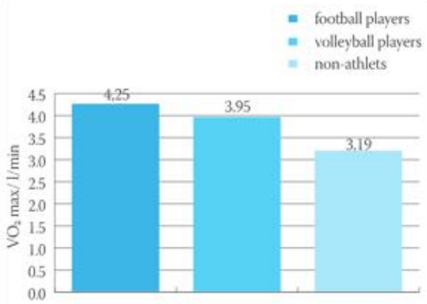


FIGURE 1. Mean VO_2 max values in the investigated groups of athletes and non-athletes expressed in l/min

Examinees	VO_2max/BW ml/kg/min	SD
Football players	51,70*#	1,12
Volleyball players	45,40*	1,69
Non-athletes	41,53#	1,14

Conclusions/action items:

Although this study didn't give details about a Vo2 mask, it was interesting to see how Vo2 max testing can used when testing athletes. Understanding the implications of the device we are designing is important to highlight and acknowledge.

VICTORIA HEILIGENTHAL - Sep 13, 2021, 6:17 PM CDT


AEROBIC CAPACITY AS AN INDICATOR IN DIFFERENT KINDS OF SPORTS

2734-Article_Text-10441-1-10-20171129.pdf(172 KB) - download

Standard Data and Values Collected-10/18/21

VICTORIA HEILIGENTHAL - Oct 18, 2021, 10:26 AM CDT

Title: Standard Data and Values Collected

Date: 10/18/21

Content by: Victoria

Present: N/A

Goals: To record standard values for variables collected during VO2 max testing and to understand how it is used to benefit participants.

Content:

VO2 MAX 101 - HOW TO TEST, CALCULATE AND IMPROVE IT (training4endurance.co.uk)

Standard values, what it collected, how its collected, how it helps

Standard relative VO2 max values:

- Elite Endurance Women: 60-75 ml/kg/min
- Elite Endurance Men: 70-85 ml/kg/min
- 20-29 age women: 33 ml/kg/min
- 20-29 age men: 42.5 ml/kg/min

Why VO2 max is important

- Higher VO2 max means better cardiovascular fitness
- indicates uptake of oxygen in lungs (lung function), circulation of oxygen (heart and cardiovascular system), using oxygen (muscular system)
- Having higher is targeted
  - Can work harder for longer before the need for oxygen exceeds the amount available
  - Also allow for faster recovery
- Factors can affect (age, gender, training, etc)

How Performed?

- Mask measures total volume of inhaled air, % of O2 and CO2 in exhaled air and calculates oxygen consumption
- Intensity of activity is increased until can no longer continue
- Increase speed, gradient, power, resistance
- Max is VO2 value that is the highest over period tested
- May have plateau
  - shows min intensity for generating VO2 max
- Also collect heart rate

Conclusions/action items: By looking at each piece of VO2 testing, we can have a better understanding of what kind of data we will be recording. We might need to ask JHT if they collect any other variables of data

VO2 max physiology-11/23/21

VICTORIA HEILIGENTHAL - Nov 23, 2021, 8:00 PM CST

Title: VO2 max physiology

Date: 11/23/21

Content by: Victoria

Present: N/A

Goals: To understand the physiology behind VO2 max testing

Content:

Physiology of Maximal Oxygen Consumption | VO2 Master

- Max oxygen uptake
  - ability for body to use oxygen in skeletal muscle mitochondria
  - Measures cardiopulmonary ability
- Oxygen in body
  - Oxygen is last electron acceptor in electron transport system
  - Mitochondria in ETS-must get to mitochondria quickly
  - oxygen first brought into lungs after inspiratory muscles expand them to allow air to move in
  - Oxygen diffuses through alveoli to move to blood
  - Oxygen bounded to hemoglobin in red blood cells (erythrocytes)
  - RBCs carry oxygen to areas of body with low oxygen, like muscles during exercise
  - Oxygen diffuses to capillary walls then bounded to myoglobin that carries it to muscles
  - Myoglobin carries to mitochondria where it is last electron acceptor in ETS production
- VO2 max limitations
  - Pulmonary diffusion capacity
    - lungs to take in large amounts of oxygen and exchange CO2 and O2 through alveoli
  - Cardiac output
    - heart pumps a lot of oxygenated blood to muscles
  - Oxygen carrying capacity of blood
    - amount of oxygen that can be carried to muscles
  - Skeletal muscle oxygen extraction
    - the mitochondria in muscles to use oxygen

Conclusions/action items: By understanding the physiology behind gas exchange, it is easier to understand how VO2 max levels are reached

Mask vs. Alternatives Testing system-9/20/21

VICTORIA HEILIGENTHAL - Sep 20, 2021, 10:06 AM CDT

Title: Mask vs. Alternatives Testing Systems

Date: 9/20/21

Content by: Victoria

Present: N/A

Goals: To document further difference in mask testing systems vs other alternatives

Content:

Search: alternative to vo2 mask during testing, Google

Citation : D. R. Wagner and N. W. Clark, "Similar results for face mask versus mouthpiece during incremental exercise to exhaustion," *Journal of Sports Sciences*, vol. 34, no. 9, pp. 852–855, May 2016, doi: 10.1080/02640414.2015.1075058.

Alternative Approach to Maximal Exercise Testing and VO2max Prediction in College Students (researchgate.net)

Similar to other articles, this study compared the mouthpiece/nose clip system to the mask system during testing. The nose and mouthpiece system could be uncomfortable for participants as they complain of dry mouth, not being able to swallow and limits communication. However, the face mask might not provide a tight enough seal to prevent air leakage.

This study again found that there was no difference in VO2 values, performance or effort when using the mask vs the mouthpiece system at all levels of exercise tested. This study also found that there was no clear preference over the different systems. Participants said the mask was more comfortable and being able to breath through the nose was a benefit. Those who liked the mouthpiece said it was easier to breath and **vision was not restricted.**

Mouthpiece system: 7200 Two-Wat Non Breathing Valves Two-Way Non Rebreathing Valves | Hans Rudolph inc. (rudolphkc.com)

Made of silicon rubber

Mask system: 7450 V2 series face mask (Hans Rudolph, Inc) 7450 V2 Series Reusable Mask with MEDGRAPHICS Mask Adapter | Hans Rudolph inc. (rudolphkc.com)

Face piece made of Silicone Rubber Blue, Polycarbonate Thermoplastic

Do different testing systems affect running economy?

Search: From "Measurement of Aerobic Capacity Using Mouthpiece vs. Mask for Data Collection" Study

Citation: S. Wl, “Is running style and economy affected by wearing respiratory apparatus?,” *Medicine and science in sports and exercise*, vol. 25, no. 2, Feb. 1993, Accessed: Sep. 20, 2021. [Online]. Available: https://pubmed.ncbi.nlm.nih.gov/8450730/

[Is running style and economy affected by wearing respiratory apparatus? - PubMed (nih.gov)](https://pubmed.ncbi.nlm.nih.gov/8450730/)

This study looked at the differences in running gaits over 10 minutes of runners when wearing a mask vs a mouthpiece system. They looked at Stride length, vertical oscillation of the center of mass, hip and ankle range of motion, and average internal mechanical power output of the runners to compare between the two systems. It was found that there was no significant difference in the gaits between the two systems.

Conclusions/action items:

This is another study that shows that both masks and mouthpieces/nose clips can be used for testing since they produce the same results. Further kinds of equipment on the market were also explored to continue to looks at differences. Lastly, the other study investigated shows that the running economy and running gaits of subjects were not significantly altered between the two systems. Due to this, either system could be seriously considered for a potential design.

VICTORIA HEILIGENTHAL - Sep 20, 2021, 10:06 AM CDT


Is running style and economy affected by wearing respiratory apparatus?

Screenshot_210_.png(597.2 KB) - download

VICTORIA HEILIGENTHAL - Sep 20, 2021, 9:55 AM CDT

JSportsSci_349_852-855.pdf(797.9 KB) - download

Common Nose and Glasses Shapes-9/22/21

VICTORIA HEILIGENTHAL - Sep 22, 2021, 2:33 PM CDT

Title: Common Nose and Glass Lenses Shapes

Date: 9/22/21

Content by: Victoria

Present: N/A

Goals: Get a brief overview of some of the most common nose and glass lenses shapes

Content:

Search: most common nose shapes, Google

Nose form was shaped by climate | Penn State University (psu.edu)

Citation: “Nose form was shaped by climate | Penn State University.” https://news.psu.edu/story/456253/2017/03/16/research/nose-form-was-shaped-climate (accessed Sep. 22, 2021).

This was an article from Penn State University that summarized the affects of weather on nose shapes and structures. I chose this piece just to get the picture and the styles of nose they discuss.

Geometric

Browline

Oversized

Cat eye

Aviator

Large

Horn

Round

Square

Rectangle

Oval

Conclusions/action items: Although these observations are very general and not scientific at all, it is good to understand out audience and who might be affected by the changes in the mask. So, it is good to make sure all nose types are fitted properly and that all glass shapes will be able to be worn with the mask.

Mask materials-9/25/21

VICTORIA HEILIGENTHAL - Sep 25, 2021, 2:15 PM CDT

Title: Mask materials

Date: 9/25/21

Content by: Victoria

Present: N/A

Goals: To see what other kinds of masks are typically made of.

Content:

Search: Citation from cloth mask study

Citation:

," *COSMED*. [Online]. Available: https://www.cosmed.com/en/products/cardio-pulmonary-exercise-test/k5. [Accessed: 13-Sep-2021].

COSMED - K5: Wearable Metabolic System for both laboratory and field testing

With this mask example, it can be seen that the material used was a silicone rubber and polycarbonate thermoplastic. For most masks I have researched at looked at or have been used in past studies, they are all commonly made of these same materials. It is comfortable for the user and also prevents air leakage. The thermoplastic allows it to be moldable as well. When creating our design, it might be best to make a mold that we can put the rubber into to set in.

Conclusions/action items:

From this and other mask models, we should aim for having our mask being made of a similar material if possible. Depending on our final design, however, we may need to choose other kinds of plastics or rubbers that are appropriate.

Materials at Makerspace-10/6/21

VICTORIA HEILIGENTHAL - Oct 07, 2021, 12:27 PM CDT

Title: Materials at Makerspace

Date: 10/6/21

Content by: Victoria Heiligenthal

Present: N/A

Goals: To document the materials available at the Makerspace to print

Content:

Since we are most likely going to be 3D printing our mask at the Makerspace, it is important to know what materials they have available so we can choose the best one when we 3D print our model.

Materials can be found: 3D Printers – UW Makerspace – UW–Madison (wisc.edu)

Will need something most similar to silicone and rubber like how the current masks are

- This link is from Formlabs: Find the Right 3D Printing Material for Your Application (formlabs.com)
  - According to the website, Elastic and Flexible Formlabs material would be best
  - Soft and stretchy material
  - Elastic-bend, stretch, compress, durable
  - Flexible-stiff soft touch, softness and strength, same as above
- We can always ask people at the MakerSpace what they recommend as well

Search: material most similar to silicon to 3d print, 3D Print Rubber - 3D Printing Gaskets - Rubber 3D Printing (rapidmade.com)

- Thermoplastic polyuethrane
- thermoplastic elastomer

Conclusions/action items: It is important to know what materials will be best for 3D printing the majority of the mask design. Depending on which design we go with for the final design, some additional or alternative materials might need to be considered.

Forces during testing-9/25/21

VICTORIA HEILIGENTHAL - Sep 25, 2021, 4:53 PM CDT

Title: Forces Generated During testing

Date: 9/25/21

Content by: Victoria

Present: N/A

Goals: Document how force calculations can be measured for testing

Content:

It is going to be important to take into account how much force the body is feeling from Ground Reaction Forces during running. This will be good to have as physical values to know how much force the glasses are going to have to withstand during testing. However, if we can use the biomechanics lab at JHT, hopefully we could use their force plates so we can collected force data that way.

- F = ma
  - Find acceleration based on treadmill speed
  - Mass from subject
- Fx, Fy, Fz values from treadmill could also be found if using force plates.

Conclusions/action items: By calculating GRF values, we can use that as justification to show how important it is to make sure we have a good design that can keep the glasses on the subject during testing as well as not interfering with the mask.

VO2 Max calculations-9/25/21

VICTORIA HEILIGENTHAL - Sep 25, 2021, 3:47 PM CDT

Title: VO2 Max Calculations

Date: 9/25/21

Content by: Victoria

Present: N/A

Goals: To document how VO2 max calculations are made so when we do experimenting, we can accurately calculate specific values.

Content:

Aerobic capacity as an indicator in different kinds of sports - PubMed (nih.gov)

Search: "vo2 max test for athletes", PubMed

Citation:

G. Ranković *et al.*, “Aerobic Capacity as An Indicator in Different Kinds of Sports,” *Bosnian Journal of Basic Medical Sciences*, vol. 10, no. 1, pp. 44–48, Feb. 2010, doi: 10.17305/bjbms.2010.2734.

Both pieces explains how VO2 max was calculated during an experiment:

- ml/min of oxygen uptake were measured
- Further divided that by the bodyweight of the individual
- Measured this until this value plateaued
  - This value is the VO2 max value
  - RER(respiratory exchange ratio-CO2 in vs CO2 out)

How to know reached VO2 max?

VO2 Max (unm.edu) “VO2 Max.” https://www.unm.edu/~lkravitz/Exercise%20Phys/VO2max.html (accessed Sep. 25, 2021).

- RER>1.15
  - CO2 expired vs O2 inhaled
- +/- 10 heart beats per min (heart rate)predicted HR
  - Predicted: 220-Age
- Plateau of <= 150 mL O2/min
- RPE >17 (Rating of perceived effort)
  - 6-20 scale

Rating of Perceived Exertion (RPE) Chart

RPE Number	% of Effort	Description of Effort
6	20% Effort	No Exertion At All
7	30% Effort	Very, Very Light (Rest, Extremely Weak)
8	40% Effort	
9	50% Effort	Very Light (Very Weak)
10	55% Effort	
11	60% Effort	Light (Weak)
12	65% Effort	Moderate
13	70% Effort	Somewhat Hard --- Steady Pace
14	75% Effort	
15	80% Effort	Hard (Strong, Heavy)
16	85% Effort	
17	90% Effort	Very Hard (Very Strong)
18	95% Effort	
19	100% Effort	Very, Very Hard (Extremely Strong)
20	Exhaustion	Maximal

How will we calculate if not provided with VO2 test system?

[VO2 max - Wikipedia](https://en.wikipedia.org/wiki/VO2_max)

"VO_2 max," *Wikipedia*. Aug. 24, 2021. Accessed: Sep. 25, 2021. [Online]. Available: https://en.wikipedia.org/w/index.php?title=VO2_max&oldid=1040490373

- Heart rate ratio
  - VO2max = HRmax/HRrest *15.3mL/kg*min
- Cooper test
  - d-504.9/44.73
  - d = distance covered in 12 minutes
- Rockport fitness walking test
  - 132.853-0.0769(BW)-0.3877(age)-3.22649(t,min)-0.1565(HR)+x
    - x = 6.315 for males, 0 for females

These calculations could be used if we do not have access to the biomechanics lab at JHT. We would test our design vs the design currently used at JHT and use the same calculations for both.

Conclusions/action items: Understanding how to collect the VO2 max data is extremely important to know in order to get accurate results to see how efficient our design is.

Statistical Analysis-12/5/21

VICTORIA HEILIGENTHAL - Dec 05, 2021, 8:11 PM CST

Title: Statistical Analysis

Date: 12/5/21

Content by: Victoria

Present: N/A

Goals: To understand how the statistical analysis for the tests will be run

Content:

Jakob has documented in his notebook the test that will be run statistically on the data. His entry is called "Statistical Analysis Method for Discrete Data" and it discusses the Wilcox Signed Rank Test and what it is.

Conclusions/action items: Now that the team knows the appropriate test to run statistics on the data, the results can be analyzed.

Johnson Health Tech Vo2 Mask, Procedures-9/22/21

VICTORIA HEILIGENTHAL - Oct 18, 2021, 9:20 AM CDT

Title: JHT Current VO2 Mask and Protocols/Procedures

Date: 9/22/21

Content by: Victoria

Present: N/A

Goals: To show what the current mask model JHT uses so we can change it based on their needs. Also to document their procedures

Content:

Citation:

[1]	J. H. Tech, "VO2 Instructional JHT," 2019.
[1]	J. Muench, "Step+ VO2 Validation," 2018.

Attached to this entry are the protocols used by JHT during testing as well as the cleaning instructions for the mask.

Conclusions/action items:

These protocols can be used when we do reliability testing for our designs.

VICTORIA HEILIGENTHAL - Sep 22, 2021, 1:59 PM CDT

VO2_Instructional_JHT.docx(1 MB) - download

JHT_testing_protocols.docx(89 KB) - download

VO2 Max standards, procedures, protocols-9/25/21

VICTORIA HEILIGENTHAL - Sep 25, 2021, 5:17 PM CDT

Title: VO2 Max standards, procedures, protocols

Date: 9/25/21

Content by: Victoria

Present: N/A

Goals: To understand the protocols, procedures and standards for VO2 max testing

Content:

Protocols

Search: "treadmill test protocols" Google

Treadmill protocols for determination of maximum oxygen uptake in runners. (nih.gov)

Citation: T. R. McConnell and B. A. Clark, “Treadmill protocols for determination of maximum oxygen uptake in runners.,” *Br J Sports Med*, vol. 22, no. 1, pp. 3–5, Mar. 1988.

Treadmill Stress Testing - StatPearls - NCBI Bookshelf (nih.gov)

Citation: V. Vilcant and R. Zeltser, “Treadmill Stress Testing,” in *StatPearls*, Treasure Island (FL): StatPearls Publishing, 2021. Accessed: Sep. 25, 2021. [Online]. Available: http://www.ncbi.nlm.nih.gov/books/NBK499903/

- Use speed protocols
    - The study above used 4 test protocols
    - P1 and P2 were at same speed, but for different testing durations
    - P3 was tested at the mean pace of all subjects
    - P4 was tested at the speed the participants could choose on the treadmill
    - Important to use so can see the results at different testing levels and ensure the results are compatible with each other
- Bruce Protocol for Stress Testing
    - 3 minute stages
    - Walk at faster speeds each stage with an increase in incline as well
    - Can be adjusted based on tolerance for 6-12 minutes

Standards

Search: "vo2 max standards"

Aerobic fitness norms for males and females aged 6 to 75 years: a review - PubMed (nih.gov)

Citation: E. Shvartz and R. C. Reibold, “Aerobic fitness norms for males and females aged 6 to 75 years: a review,” *Aviat Space Environ Med*, vol. 61, no. 1, pp. 3–11, Jan. 1990.

- This study found some mean norms and standard values for vo2 max testing across a wide range of ages and over both sexes
- Males
    - 1 L/min - 6 yrs, 12 L/min-12 yrs, 3.4 L/min-18 yrs
    - Decline to 3.2, 2.7, 1.6 L/min for 30, 50, 75 respectively
    - 47.5, 50, 48, 35, 25 for above age groups (ml/kg/min)
- Females
    - 0.9,1.8,2.2,1.8,1.1 L/min - 6, 12, 18, 30, 50 75 years
    - 42.5,44,41,2817.5 (ml/kg/min) for above age groups

- Shows that vo2 max peaks at a certain age, then drops

Procedures

- The procedures followed should be consistent with the ones documented and provided by JHT

Conclusions/action items:

Prior to testing, it is very important to lay out the standards, protocols and procedures so we can make sure our data is accurate and collected properly. We will also need to consider safety protocols for testing and for the mask.

VO2 Max Testing conditions-9/28/21

VICTORIA HEILIGENTHAL - Sep 28, 2021, 12:52 PM CDT

Title: VO2 Max Testing Conditions

Date: 9/28/21

Content by: Victoria

Present: N/A

Goals: Document the conditions and the environment subjects will be in during testing

Content:

- Temperature
  - The temperature of the laboratory could affect how the runner feels during the test
- Humidity
  - The humidity is also a big factor. The amount of water in the air can cause the subject to feel different depending on the conditions
- Sweat
  - The subjects will begin to sweat during the tests
- Saliva
  - Regardless of the design, the subject is going to be exposed to saliva from the mouthpiece. This might cause discomfort

Conclusions/action items:

It is important for us as designers to understand the conditions and environment the test subjects will be placed under. This can help us modify our design to create the most comfortable design.

Johnson Health Tech-10/18/21

VICTORIA HEILIGENTHAL - Oct 18, 2021, 9:12 AM CDT

Title: Johnson Health Tech

Date: 10/18/21

Content by: Victoria

Present: N/A

Goals: To document what the client does

Content:

Johnson Health Tech

Citation: “Johnson Health Tech.” https://www.johnsonhealthtech.com/us/eng/about-us (accessed Oct. 18, 2021).

- Exercise and fitness equipment manufacturer
- Based out of Cottage Grove, WI
- Designs pieces like treadmills, bikes, ellipticals, steppers

Conclusions/action items: It is important to highlight exactly what the client exactly does to gain a better understanding of how we are going to be impacting the company.

New testing protocol-10/28/21

VICTORIA HEILIGENTHAL - Nov 23, 2021, 7:40 PM CST

Title: New Testing Procedure/Protocol

Date: 10/28/21

Content by: Victoria

Present: N/A

Goals: To outline the new type of testing the client has requested

Content:

After being in contact with the client after discussing the new direction we are heading in for our design, our client informed us of a new way of testing they wanted us to conduct. Rather than performing equivalence testing, the client said it would be appropriate for the team to conduct functional testing instead.

The client has suggested that for functional testing, we can test the mask on a treadmill for 2-3 different speeds, an Accent trainer (elliptical) and spin bike. We can test the clips/mask design on the pieces of equipment to ensure the mask is functioning properly and appropriately. It might still be important to ask for data previously collected from JHT for VO2 max tests using the previous mask to ensure our results are similar to their previous results. However, knowing this about the testing is important before we start outlining our testing procedure to collect data.

Conclusions/action items: Moving forward, the team can work on outlining testing procedures and protocols for when we

Cloth Material Effect on Masks During Exercise-9/13/21

VICTORIA HEILIGENTHAL - Sep 13, 2021, 11:03 AM CDT

Title: Cloth Material Effect on Masks During Exercise

Date: 9/13/21

Content by: Victoria

Present: N/A

Goals: To understand why certain materials (cloth in this case) should or should not be used for a mask during exercise testing

Content:

Search: "what masks are sued during vo2 max testing", Google

Citation:

S. Driver, M. Reynolds, K. Brown, J. L. Vingren, D. W. Hill, M. Bennett, T. Gilliland, E. McShan, L. Callender, E. Reynolds, N. Borunda, J. Mosolf, C. Cates, and A. Jones, “Effects of Wearing a Cloth Face Mask on Performance, Physiological and perceptual Responses During a graded Treadmill Running Exercise Test,” *Br J Sports Med*, 13-Apr-2021.

- COVID restrictions required people to wear cloth masks during exercise
    - Surgical masks can get wet and release germs and not block viruses
- Study aimed to see how wearing a cloth face mask affected exercise performance
    - Exercise time, Vo2 max, perceived exertion, and participants experience
- Mask materials: 88% polyester/12% elastane, cotton lining
    - metabolic testing equipment was placed overtop cloth mask
- Completed different levels of speeds on treadmill and data was collected
    - Shown that exercise time, VO2 max were decreased
    - Participants felt short of breath and claustrophobic- not comfortable

Conclusions/action items:

By reading this study, it is clear that COVID restrictions impacted people during exercise and their ability to workout. This also shows that a cloth material, such as those used to make surgical masks, would not be a good material to consider for any part of the mask due to moisture and comfort problems. Although this seems obvious, it is important to address and completely remove any cloth-like material as a potential material option.

VICTORIA HEILIGENTHAL - Sep 13, 2021, 10:52 AM CDT


Effects of wearing a cloth face mask on performance, physiological and perceptual responses during a graded treadmill running exercise test

bjsports-2020-103758.full_1_.pdf(828.5 KB) - download

Metabolic Testing Supplies-9/13/21

VICTORIA HEILIGENTHAL - Sep 13, 2021, 10:29 AM CDT

Title: Metabolic Testing Supplies

Date: 9/13/21

Content by: Victoria

Present: N/A

Goals: To see what is used during typical metabolic testing, such Vo2 max testing and other exercise stress related testing so we can get a basic understanding of what our design could look like and what it needs to include.

Content:

Search: Vo2 max testing, Google patents

Citation: SUPPLIES & ACCESSORIES FOR METABOLIC TESTING," *VacuMed*. [Online]. Available: https://www.vacumed.com/zcom/product/Product.do?compid=27&prodid=8217. [Accessed: 13-Sep-2021].

VacuMed | Metabolic Testing equiptment, Cardiopulmonary Testing systems

- Products shown have single and multiple use pieces of equipment
    - Have resting metabolic testing and exercise testing equipment
- Pieces include mask, T-valve and tubing

Mask used for Vo2 testing during COVID

VacuMed | Metabolic Testing equiptment, Cardiopulmonary Testing systems

- Parts include: face piece, headgear, face piece to breathing valve adapter, breathing valve, filter
- This design is reusable and auto-clavable
- Multiple sizes
- Silicone, easy to wear and fit
- Ripped support to prevent leakage

Adapters to Pneumotach and 35mm Breathing Valves
To connect pneumotach to Breathing valve with 35mm OD port use part # CC1067.

To connect pneumotach to V2 mask, use part # CC1748 or CC1265. See photo below.

Conclusions/action items: By seeing this design, we can start to see how the mask is constructed and what we need to consider before we start brainstorming design ideas.

COSMED K5 Metabolic System-9/13/21

VICTORIA HEILIGENTHAL - Sep 13, 2021, 11:08 AM CDT

VICTORIA HEILIGENTHAL - Sep 13, 2021, 11:27 AM CDT

Title: COSMED K5 Metabolic System

Date: 9/13/21

Content by: Victoria

Present: N/A

Goals: To investigate the metabolic testing system used by the study I found that was seeing how cloth masks affected exercise and performance.

Content:

Search: Citation from cloth mask study

Citation:

"K5," *COSMED*. [Online]. Available: https://www.cosmed.com/en/products/cardio-pulmonary-exercise-test/k5. [Accessed: 13-Sep-2021].

COSMED - K5: Wearable Metabolic System for both laboratory and field testing

System:

- Used for metabolic testing at exercise and at rest, stress ECG testing, and heart rate testing
- Gas exchange is measured using micro-dynamic mixing or breath by breath
- Wireless and BT capabilities, AC/DC plug, USB port
- Light weight, water and dust resistant, touch screen
- Can get other accessories to use with testing such as swimming water mask, stress ECG and a pulse oximeter

Face mask:

- Reusable and can be used for 2-3 hours at any exercise intensity
- Silicone rubber
- Contoured design with ribbed structure to reduce leakage
- Chin cup for stability
- Multi-size for multiple patients
- 5 adjustable strap clips for easy use
- Steam autoclavable, cold chemical, dishwasher safe, pasteurization
- Technical specifications are shown below and in the PDF

Internal testing shows significant reduced inspiratory resistance starting already from 80 Liter/min. At 150 L/m resistance to flow is 1/2 compared with masks without valves.

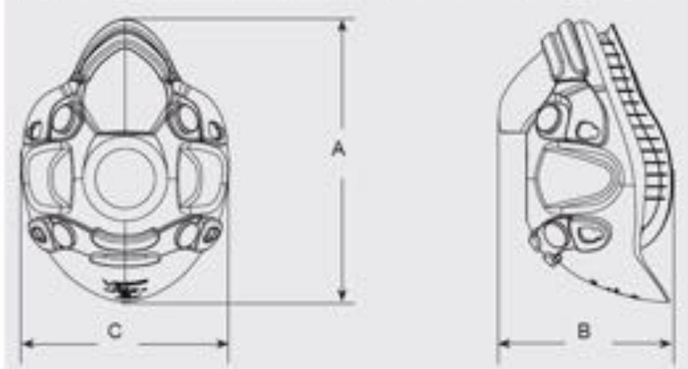
Face masks without inspiratory valves are recommended when performing Exercise Flow/Volume Loops (EFVL).

RMR testing with pediatric face mask.

Technical specifications

V2 Mask			
for Turbine 2000 w/ Inspiratory Valve		Application	Compatible Products
C04324-01-10	Small	Valves reduce inspiratory resistance, ideal for Performance testing.	K5, Quark CPET, Quark PFT, K4 b², Quark b²
C04324-02-10	Medium		
C04324-03-10	Large		
C04324-04-10	X-Small		
for Turbine 2000 w/o Inspiratory Valve			
C03701-01-10	Small	For clinical or performance applications. Required when EFVL (Exercise flow volume loops) must be captured.	K5, Quark CPET, Quark PFT, K4 b², Quark b²
C03702-01-10	Medium		
C03703-01-10	Large		
C03704-01-10	X-Small		
C03705-01-10	Petite		
for VO_2max flowmeter w/o Inspiratory Valve			
C03611-01-10	Small	For clinical or performance applications.	Fitmate PRO, Fitmate MED, Spiropalm 6MWT
C03612-01-10	Medium		
C03613-01-10	Large		
C03616-01-10	X-Small		
C03620-01-10	Petite		
for RMR flowmeter w/o Inspiratory Valve			
C03617-01-10	Small	For Resting applications only	Quark RMR, Fitmate line, Quark PFT (REE), Quark CPET (REE)
C03618-01-10	Medium		
C03619-01-10	Large		
C03614-01-10	X-Small		
C03615-01-10	Petite		
Head Cap			
A-800-900-023	Head cap adult for Small or Medium		
A-800-900-022	Head cap adult for Large		
A-800-900-024	Head cap for Extra Small or Petite		
Materials			
Face Piece with Structural Braces		Silicone Rubber (blue), Polycarbonate Thermoplastic	
Headgear		Polyurethane Foam (black), Nylon UBL (gray) and Nylon Fabric (red)	
Biocompatibility		Statement 10993-1	
Headgear Hook		Nylon, black	
Headgear Strap Clips (4), Tri-glide		Polypropylene, black	
Custom Mask Adapters		Polycarbonate Thermoplastic	

Dimensions	Mask face Piece Sizes				
	Large (L)	Medium (M)	Small (S)	Extra Small (ES)	Petite (P)
A (in/cm)	5.9/15	5.6/14.2	5.2/13.2	4.8/12.2	4.6/11.7
B (in/cm)	3.7/9.4	3.4/8.6	3.2/8.1	3.1/7.8	3.0/7.6
C (in/cm)	4.2/10.6	4.2/10.6	4.0/10.2	3.9/10	3.9/10
Deadspace (ml)	143	125	99	88	78
Weight (gr)	128	118	100	89	83



Conclusions/action items:

This product seems like a model that we could use to brainstorm design ideas from. Depending on our clients requirements, this product has a lot of qualities that would be attractive to an athlete and a researcher. Although this isn't just the face mask, it has a lot of other metabolic pieces that could be beneficial to consider. I think this face mask should be a large contributor to helping us determine our design.

VICTORIA HEILIGENTHAL - Sep 13, 2021, 11:25 AM CDT

Face Mask

PRODUCT GUIDE

Multi-use silicone face masks with headgear for comfortable leak-free resting and exercise gas exchange measurements

PG_Facemask_C04211-02-93_A4_print_EN.pdf(2.7 MB) - download

Alternatives for Mask-9/20/21

VICTORIA HEILIGENTHAL - Sep 20, 2021, 9:18 AM CDT

Title: Alternatives to Masks Used for VO2 Max Testing

Date: 9/20/21

Content by: Victoria Heiligenthal

Present: N/A

Goals: Learn about other pieces of equipment that are used during VO2 mask testing other than masks.

Content:

Search: aerobic testing mask for research, Google

Citation: K. B. Dawes JJ, "Measurement of Aerobic Capacity Using Mouthpiece vs. Mask for Data Collection," *J Nov Physiother*, vol. s2, no. 01, 2012, doi: 10.4172/2165-7025.S2-002.

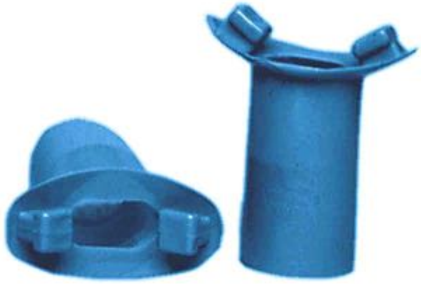
Measurement of Aerobic Capacity Using Mouthpiece vs. Mask for Data Collection | OMICS International (omicsonline.org)

In this study, they compared the differences between using a mask vs. a mouthpiece, nose clip and headgear apparatus (MNH) for aerobic capacity testing. The MNH system has been avoided due to losing the nose piece during testing, but the mask also pose leakage issues. The results of this study showed that there was no difference in the VO2 max values (as well as other aerobic capacity values) when using the mask vs the MNH system. This means that leakage was not a problem during testing with either system. The participants stated that the MNH system was more uncomfortable and also influenced how they ran during testing. Due to this, this study recommended the mask for VO2 testing over the MNH system.

The study did conclude, along with other studies, that different facial features of participants could be a potential cause for gas leakage. Running economy could also lead to skewed results if the participant is uncomfortable.

MASK used during test: Air cushion mask, VacuMed

Mouthpiece and nose clip used during testing: #1001 Medium-Large Mouthpiece, VacuMed

Conclusions/action items:

This study is extremely helpful for us when looking at competing designs. We could consider using the mouthpiece and nose clip design for subjects with glasses because it would allow them to wear their glasses during testing. Although it might be a little more uncomfortable, the results from using a mouthpiece and nose clip are very similar to those of a mask. This should be a strong consideration for one of our potential designs.

VICTORIA HEILIGENTHAL - Sep 20, 2021, 9:21 AM CDT

Novel Physiotherapies

Measurement of Aerobic Capacity Using Mouthpiece vs. Mask for Data Collection

measurement-of-aerobic-capacity-using-mouthpiece-vs-mask-for-data-collection-2165-7025.S2-002.pdf(1.2 MB) - download

Masks that allow for glasses-11/23/21

VICTORIA HEILIGENTHAL - Nov 23, 2021, 7:47 PM CST

Title: Masks that allow for glasses

Date: 11/23/21

Content by: Victoria

Present: N/A

Goals: To determine if there are any masks on the market that allow uses to wear glasses during testing.

Content:

After extensive research, there are currently no VO2 masks on the market that are specifically made to allow users to wear glasses during testing. I am assuming most users either wear contacts when they test or do not wear glasses at all during testing. In addition, when I reached out to the manufacturer of the mask the client uses, the employee of the company I was in contact with informed that the masks should be able to be worn with glasses. They said the client might be having issues with correct sizing of masks for certain users to allow them to wear glasses during testing. However, the client is clearly having issues with this since they have asked us to design a mask to specifically allow users to wear glasses during testing. A screenshot of the email from the manufacturer s shown below.

Victoria,

The 7450 Series Masks allow glasses to be worn currently without making changes. The mask is not meant to ride up the face and touch the Sellion area where your nose meets your forehead. The mask is mean to be positioned a few CM down from the Sellion impression. Bring the apex of the mask down.

These masks run very large so using our mask sizing Gauge (p/n 691143) helps. In exercise and pft testing there are not really any other masks used in the world but in NIV and CPAP there are and this same V2 design is used in our NIV and CPAP Masks and we are two sizes larger than our competitors in those markets. So please consider if you were fitting a person with a Medium size 7450 that two sizes smaller would be our Extra Small size and that would be a better choice for the persons face. The apex of the mask will end up approx. a half inch or so down the nose and that will allow glasses to easily be worn. Many NIV and CPAP patients like our mask for that reason among other benefits of good seal, comfort, ease of use and cleaning, durability, etc.

Please let us know the results of your further testing and evaluation and your further questions or requirements.

Conclusions/action items: By not having any competing designs on the market, this greatly shows the needs of the client.

My Design Ideas for Design Matrix Team Meeting-9/25/21

VICTORIA HEILIGENTHAL - Sep 25, 2021, 5:31 PM CDT

Title: Design Ideas for Design Matrix

Date: 9/25/21

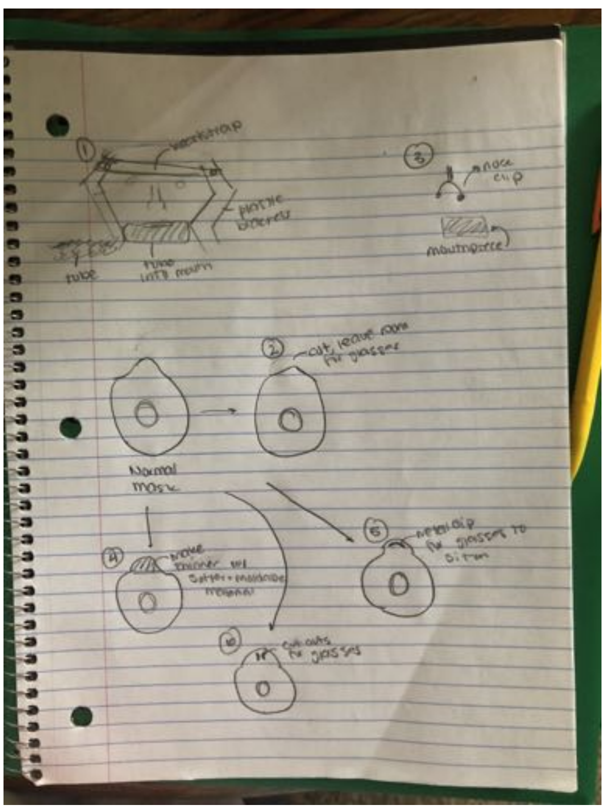
Content by: Victoria

Present: N/A

Goals: Generate design ideas to bring to our team's design matrix meeting

Content:

1. Headgear with plastic on the sides and mouth piece-no covering over nose
2. Make masks end lower on the bridge of the nose to allow for glasses use
3. Nose plug and mouthpiece
4. Make mask thinner at the top of the nose bridge that is made of a softer and more molded material
5. Put a wire nose strip across the top to allow for bending at the bride of the nose and for a place that glasses can securely sit on
6. Have hole for nose piece of glasses to fit inside mask, allows for stability of glasses on mask and prevent falling off or moving



Conclusions/action items: By brainstorming some ideas, I can bring my two main ideas to our team meeting and we can collectively decide on a design.

Hand drawn Sketches of Designs-10/17/21

VICTORIA HEILIGENTHAL - Oct 17, 2021, 9:14 PM CDT

Title: Hand drawn Sketches of Designs

Date: 10/17/21

Content by: Victoria

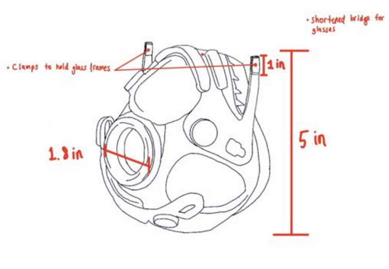
Present: N/A

Goals: To document and better display the designs brainstormed by the team

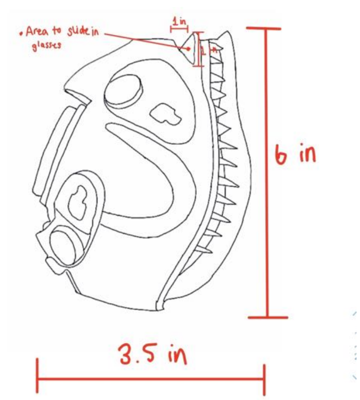
Content:

All images were drawn by Sinan

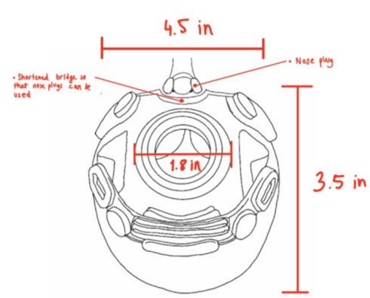
-Clamps and lower bridge design



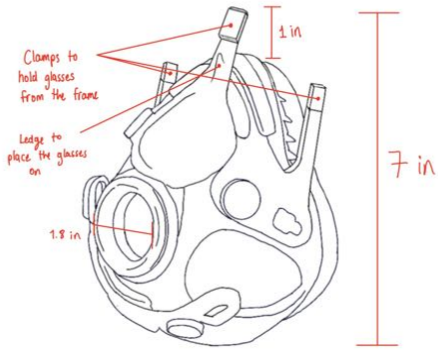
-Divot design



-Nose clip design



-Final design (clamps on side and front of mask to hold glasses)



Conclusions/action items: These sketches help show a better picture of what the team is going to be fabricating this semester.

Clips brainstorming-10/28/21

VICTORIA HEILIGENTHAL - Oct 28, 2021, 2:07 PM CDT

Title: Clips apparatus brainstorming

Date: 10/28/21

Content by: Victoria

Present: N/A

Goals: Generate ideas for the clip apparatus piece of the mask

Content:

Prior to our team meeting discussing how we will develop our clip portion of the mask, we each brainstormed how we could incorporate the clips comfortably onto the mask. My idea included 3D printing a plastic extension piece that had holes and extrusion holds on it that could be used to wrap around the legs of the glasses and clip into place. This would allow for variation in face shape and glasses shape since it would accommodate for all people.

My idea is similar to how a watch strap functions (except we would combine the functions of both straps into one). The strap can wrap around the legs and can be adjusted for comfort and for size/shape.

Conclusions/action items: I will take these ideas to share with my team so we can all work together and collaborate on exactly how the clips will be structured.

Show and Tell Ideas-11/5/21

VICTORIA HEILIGENTHAL - Nov 05, 2021, 7:13 PM CDT

Title: Ideas from Show and Tell

Date: 11/5/21

Content by: Victoria

Present: N/A

Goals: To gain feedback and suggestions on areas we are struggling with in regards to our design

Content:

Areas of struggle we received feedback on:

- Plastic Piece material
  - elastic resin-angles and other components wouldn't have to be precise
- How to model plastic piece
  - molding
  - model ourselves
  - get file from manufacturer
  - 3D scan
  - look on websites with already given stl files
- Plastic piece components
  - put hole in plastic pieces given to create snap apparatus of extension piece

Conclusions/action items: Each of these ideas and suggestions will be really useful for the team moving forward. We plan to mainly focus on changing the material of the pieces, modeling them ourselves through CAD or scans, or creating a snap piece on the pieces given already.

Quantitatively Measuring Mask-10/7/21

VICTORIA HEILIGENTHAL - Oct 07, 2021, 12:31 PM CDT

Title: Quantitatively Measuring Mask

Date: 10/7/21

Content by: Victoria

Present:N/A

Goals: To layout how the team is going to quantitatively ensure the design is adequate

Content:

As a team, we need to discuss and decide on how we are going to make sure we can quantify our design so we can show how it is going to be adequate or not.

Brainstorming ideas:

- Could test our mask design and the current JHT mask design under the same conditions and collect VO2 max values
- We can compare those values together
- Need to find a percentage that we can say "above or below this shows that the mask is still functional, meets the requirements and works correctly"
    - Maybe 5-10% difference?
- This way we can run statistical analysis data across to see the deviation from our design to the current model

Conclusions/action items:

The team needs to meet and decide together how to quantify the design

Testing Results Statistics-10/8/21

VICTORIA HEILIGENTHAL - Oct 08, 2021, 1:13 PM CDT

Title: Testing Results Accuracy and Quantitative Masks

Date: 10/8/21

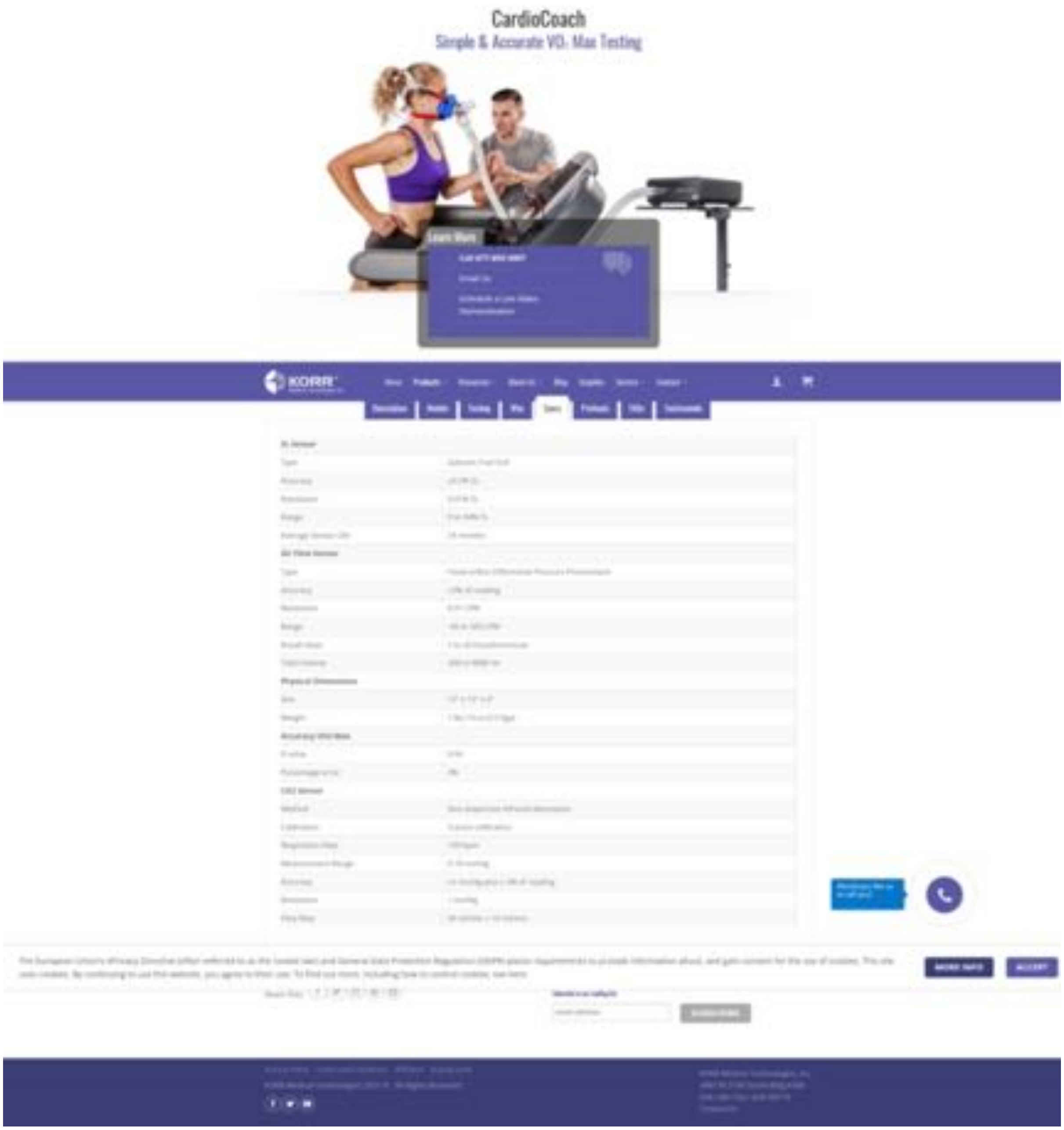
Content by: Victoria

Present:

Goals: To get some numerical values on how to quantify our mask results

Content:

In order to see how accurate and reliable our masks are, we are going to need to quantify the results. If we test our design and the masks given by JHT, we can compare the VO2 max values together to see if they are produced equivalently or similarly. In order to do this, we need some sort of percentage range that we can say, "above or below 5% (for example), will still be an adequate mask". The testing system show below shows their spec values as well as a printout of what the results look like from the testing system.



The specs of the VO2 mask testing system

We can focus on the VO2 max section and see that it has a 3% error. Using this, we can potentially determine that if our mask differs from the JHT mask by 3%, it is still in the acceptable range.

The sample page of data from the copy is also attached.

Search: "equivalency testing of vo2 max", Google

[Similar results for face mask versus mouthpiece during incremental exercise to exhaustion - PubMed (nih.gov)]()

Citation: D. R. Wagner and N. W. Clark, “Similar results for face mask versus mouthpiece during incremental exercise to exhaustion,” *Journal of Sports Sciences*, vol. 34, no. 9, pp. 852–855, May 2016, doi: 10.1080/02640414.2015.1075058.

- This journal compared the differences between mouthpieces and masks during VO2 max testing to investigate alternatives to testing

- Results showed that there was no statistical significance between the two when doing a p-test
    - When we test, we can also use a p-test to see if there was a statistical difference between the two sets of data

Conclusions/action items: We could use the percentage difference found to quantify our results. We can also use p-values to determine if our changes in results are significant or not.

VICTORIA HEILIGENTHAL - Oct 08, 2021, 1:02 PM CDT

CardioCoachVO2Test.pdf(4.8 MB) - download

Equivalence and Noninferiority Testing-10/18/21

VICTORIA HEILIGENTHAL - Oct 18, 2021, 8:45 PM CDT

Title: Equivalence and Noninferiority Testing

Date: 10/18/21

Content by: Victoria

Present: N/A

Goals: To get a clearer understanding of how we are going to compare our mask results to the masks used at JHT

Content:

Understanding Equivalence and Noninferiority Testing (nih.gov)

Citation: E. Walker and A. S. Nowacki, "Understanding Equivalence and Noninferiority Testing," *J Gen Intern Med*, vol. 26, no. 2, pp. 192–196, Feb. 2011, doi: 10.1007/s11606-010-1513-8.

What is equivalence and noninferiority testing?

- Equivalency with research hypothesis: the new model is equivalent to the past model
  - Uses equivalency margin that allows for a range of values to be "close enough" to be equivalent
- Noninferiority with research hypothesis: the new model is not inferior to the past model
  - New system is no more than equivalency margin
  - Show new system is not inferior

How is it used?

- Need to establish equivalency margin
- Use TOST test
  - (new-current)*100%
  - See if in (-equivalency margin, +equivalency margin)

How can we utilize it in our project?

- We need to establish an equivalency margin and significance level
  - Ask advisors on how to do that if no equivalency margins have been established yet
  - Only have 3% from system specs
- Use TOSTS test

Conclusions/action items: We need to make sure we discuss and ask our advisors how we set our equivalency margin if we do not have prior data to work with. However, this will be a good way of testing our mask against the current mask.


Understanding Equivalence and Noninferiority Testing

INTRODUCTION

11606_2010_Article_1513.pdf(156.3 KB) - download

New testing protocol-10/28/21

VICTORIA HEILIGENTHAL - Oct 28, 2021, 2:00 PM CDT

Title: New Testing Procedure/Protocol

Date: 10/28/21

Content by: Victoria

Present: N/A

Goals: To outline the new type of testing the client has requested

Content:

After being in contact with the client after discussing the new direction we are heading in for our design, our client informed us of a new way of testing they wanted us to conduct. Rather than performing equivalence testing, the client said it would be appropriate for the team to conduct functional testing instead.

The client has suggested that for functional testing, we can test the mask on a treadmill for 2-3 different speeds, an Accent trainer (elliptical) and spin bike. We can test the clips/mask design on the pieces of equipment to ensure the mask is functioning properly and appropriately. It might still be important to ask for data previously collected from JHT for VO2 max tests using the previous mask to ensure our results are similar to their previous results. However, knowing this about the testing is important before we start outlining our testing procedure to collect data.

Conclusions/action items: Moving forward, the team can work on outlining testing procedures and protocols for when we

Testing Outline-11/23/21

VICTORIA HEILIGENTHAL - Nov 23, 2021, 7:38 PM CST

Title: Testing outline

Date: 11/23/21

Content by: Victoria

Present: N/A

Goals: To show the testing outline for the team's design

Content:

Since the client informed the team that functional testing should be done instead of equivalency testing, the team had to rethink the testing process. The testing outline attached below shows how the team will perform testing of the design to ensure the product meets the needs of the client.

https://docs.google.com/document/d/1Bq2pSYxMYMo2MBVukLRDebboMR8lWaqNTFIMWz3vLec/edit?usp=sharing

Conclusions/action items: With this testing outline, the team is prepared for testing and shows exactly what will be done during testing.

Final Results-12/5/21

VICTORIA HEILIGENTHAL - Dec 05, 2021, 8:05 PM CST

Title: Final Results

Date: 12/5/21

Content by: Victoria

Present: NA

Goals: To document the results from testing

Content:

Below is a link of the results and statistical analysis of testing.

https://docs.google.com/spreadsheets/d/1m0d7VfwkeEJnK_FPWkkBSrefZH5et50KWbg9Jy1qVXI/edit?usp=sharing

Conclusions/action items:

Now that we have the data, we can begin to analyze it to see if the mask meets the needs of the client.

Pictures and Videos from testing-12/5/21

VICTORIA HEILIGENTHAL - Dec 05, 2021, 10:36 PM CST

VICTORIA HEILIGENTHAL - Dec 05, 2021, 10:39 PM CST

Title: Pictures and Videos from testing

Date: 12/5/21

Content by: Victoria

Present: N/A

Goals: To show how testing was completed

Content:

Images with the mask and extension pieces

Videos with mask and extension pieces and without

-cannot attach here but we have them.

Conclusions/action items: By having this documentation, it is easy to explain and show how we completed testing

Statistical Analysis-12/5/21

VICTORIA HEILIGENTHAL - Dec 05, 2021, 8:10 PM CST

Title: Statistical Analysis

Date: 12/5/21

Content by: Victoria

Present: N/A

Goals: To understand how the statistical analysis for the tests will be run

Content:

Jakob has documented in his notebook the test that will be run statistically on the data. His entry is called "Statistical Analysis Method for Discrete Data" and it discusses the Wilcox Signed Rank Test and what it is.

Conclusions/action items: Now that the team knows the appropriate test to run statistics on the data, the results can be analyzed.

Final Design Sketch-10/18/21

VICTORIA HEILIGENTHAL - Oct 18, 2021, 9:02 PM CDT

Title: Clip Apparatus Logistics

Date: 10/18/21

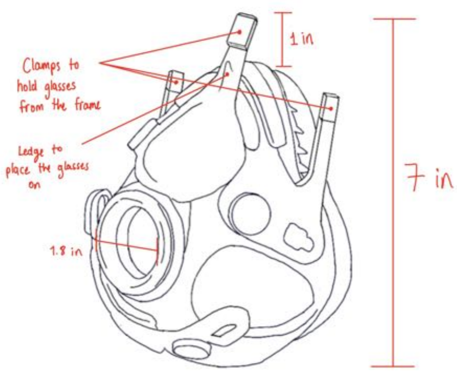
Content by: Victoria

Present: N/A

Goals: To document the final proposed design

Content:

Sketch of the final proposed design



Conclusions/action items: We can continue to build off of this design before we create our final proposed design later in the semester

Estimated Costs of Design-10/18/21

VICTORIA HEILIGENTHAL - Oct 18, 2021, 10:01 AM CDT

Title: Estimated Costs of Design

Date: 10/18/21

Content by: Victoria

Present: N/A

Goals: To get a rough cost estimate of each component of the mask

Content:

3D Printers – UW Makerspace – UW–Madison (wisc.edu)

Citation: “3D Printers,” *UW Makerspace*. https://making.engr.wisc.edu/3d-printers-2/ (accessed Oct. 18, 2021).

- Estimated cost of 3D printing the mask
- Depends on how much material we need to create both mask sizes as well as the final material we decide to go with
    - Formlabs elastic: $0.29 /mL
    - Formlabs flexible: $0.29/mL
    - Headstraps are going to be used from previous JHT masks
    - Clips cost-unsure as of 10/18

Conclusions/action items: Although this does not provide us with a concrete estimate of the cost for the design, it helps us start to think about how we are going to price out each component of the design

New Clip Design Idea-10/28/21

VICTORIA HEILIGENTHAL - Oct 28, 2021, 2:22 PM CDT

Title: Clip design apparatus final design

Date: 10/28/21

Content by: Victoria

Present: N/A

Goals: To document and finalize the clip portion of the mask

Content:

Prior to meeting, the team had decided on using clips on the side of the mask to attach to the legs of the glasses to hold them in place during testing. Originally, the team was going to reprint the entire mask and add the clip piece to the 3D print, but we realized that the small plastic pieces in the front of the original mask are removable on the mask. We thought it would be easiest if we could reprint the plastic pieces to accommodate for glasses users that can be easily added or removed from the mask depending on the subject of the test. This would also lower the potential risk for errors and leakage of the mask if a new mask was printed. The 3D CAD sketch of the new mask also might not be as identical and similar to the original mask as we want it to be. So, reprinting the plastic pieces with our design will be more cost efficient for the client, will be easier to manufacture for the client if multiple pieces want to be reprinted, and will allow for easy adjustments during testing for the client.

After brainstorming, the team has decided to add an extension piece to a plastic piece that will be able to snap into the front of the mask like the original plastic pieces. The extension piece will have a small slit in the front that will allow for a velcro strap to loop into. The velcro strap will then be used to wrap around the legs of the glasses and can be adjusted to the user's comfort. This design allows for the users to wear their glasses during testing as well as accommodating all face and glasses shapes/sizes. The pieces will most likely be plastic, but we will ask workers at the Makerspace what material would be most appropriate or most similar to the current pieces.

The only issue with the design the team is still facing is the fact that the bridge portion of the glasses will still be slightly elevated over the mask since no portion of the actual mask is being changed. However, we are hoping that the straps will hold the glasses in place enough so that the user can still see properly. We tried putting the mask on ourselves with our own glasses, and it still seemed like we would be able to see properly and having the straps would keep the glasses from moving. After printing the plastic pieces and doing initial testing just to see if they are going to work, we can determine if we need to make any adjustments to the front of the mask to account for the bridge portion of the glasses.

Conclusions/action items: Moving forward, the team is drafting CAD sketches to use for 3D printing. After having the physical prints, we can determine where to go from there; if we need to change the front of the mask for the bridge of the glasses or if we move forward with the design.

Extension Piece-11/23/21

VICTORIA HEILIGENTHAL - Nov 23, 2021, 7:34 PM CST

Title: Extension Piece

Date: 11/23/21

Content by: Victoria

Present: N/A

Goals: To document the model of the extension piece

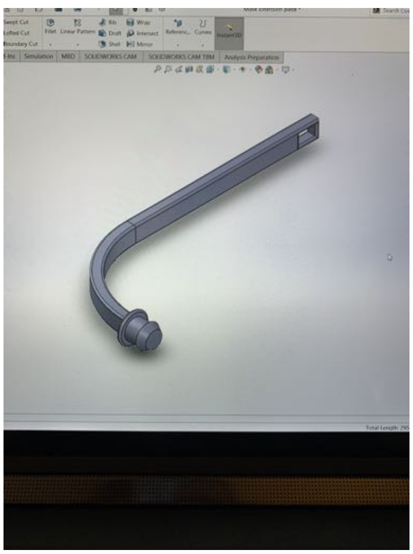
Content:

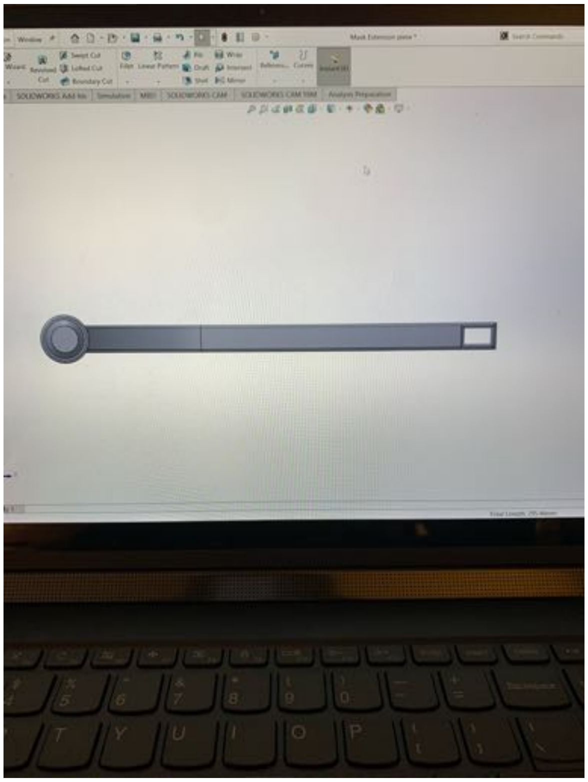
SolidWorks CAD Model:

-Shows slit where Velcro will be

-Shows angle turn to aim towards the user's glasses

-Shows how it will attach to the mask





Printed Version

Conclusions/action items: These pictures and models shows the extension piece. From here, the team can file down the piece to create a smoother finish and get ready for testing

Plastic Piece-11/23/21

VICTORIA HEILIGENTHAL - Nov 23, 2021, 7:34 PM CST

Title: Plastic piece

Date: 11/23/21

Content by: Victoria

Present: N/A

Goals: To document the plastic pieces from the mas

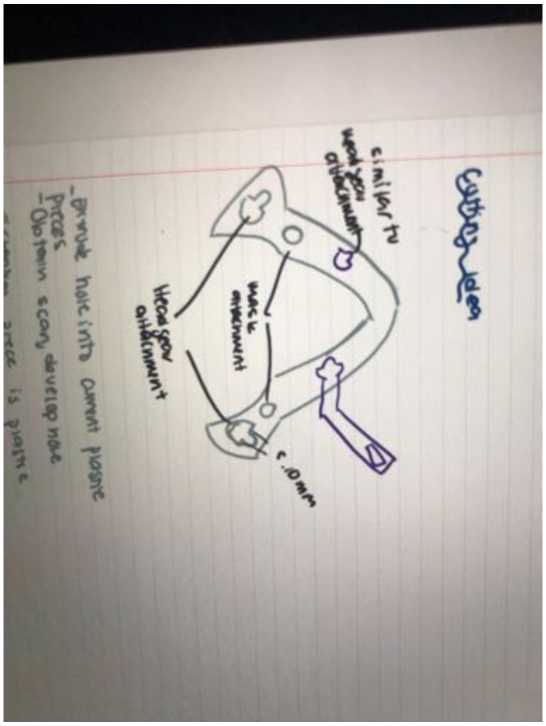
Content:

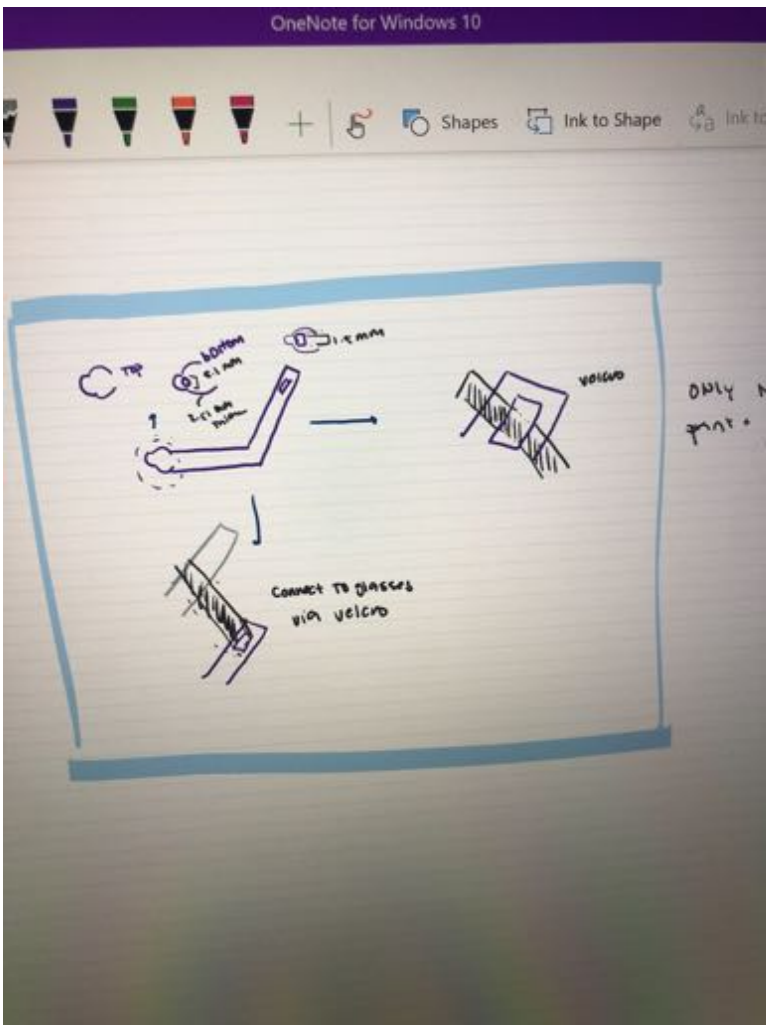
The team decided to 3D print the plastic piece from the mask from a 3D scan of the piece. This piece will allow the team to edit it and make changes rather than modifying the one on the mask from the client.

3D scanned model:

Inserted below

Sketches of plastic piece and extension piece:





Conclusions/action items: These images and files show the plastic piece of the mask for the final design

VICTORIA HEILIGENTHAL - Nov 23, 2021, 7:34 PM CST

,

Knauss_11_8_Medium.stl(119.2 MB) - download

VICTORIA HEILIGENTHAL - Nov 23, 2021, 7:34 PM CST

,

Knauss_11_8_Small.stl(119.2 MB) - download

Pictures of final design12/6/21

VICTORIA HEILIGENTHAL - Dec 06, 2021, 10:55 PM CST

Title: Pictures of Final Design

Date: 12/6/21

Content by: Victoria

Present: N/A

Goals: Show how the final design turned out

Content:

Conclusions/action items: By showing these pictures, it will be easier for the team to explain and show how the design functions.

Dimensions of extension piece-12/6/21

VICTORIA HEILIGENTHAL - Dec 06, 2021, 10:52 PM CST

Title: Dimensions of extension piece

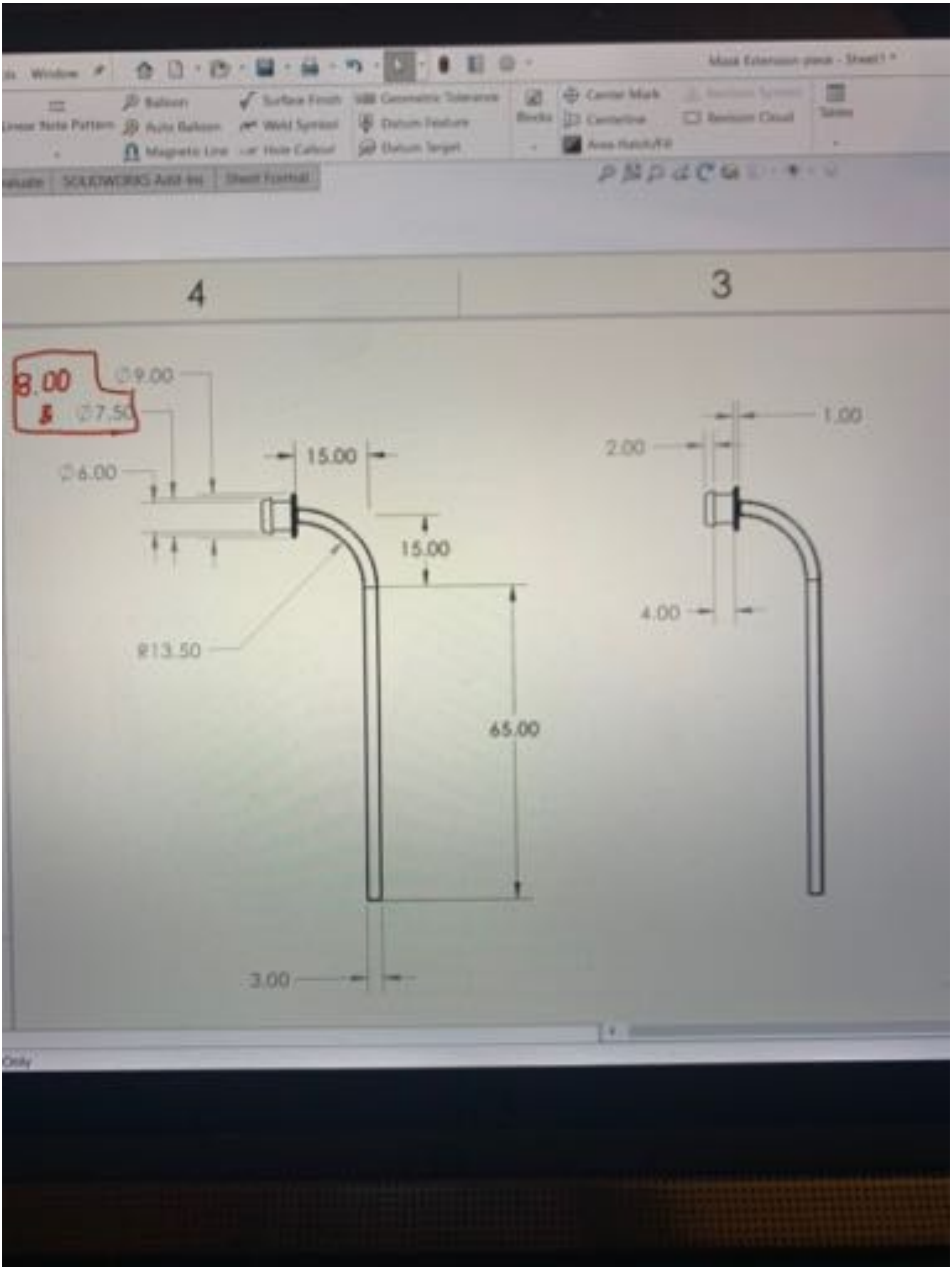
Date: 12/6/21

Content by: Victoria

Present: N/A

Goals: Document the dimensions of the extension piece

Content:



All dimensions in mm.

Two sizes were modeled, so the diameter of the insertion part of the piece was made with a 7.5- and 8-mm diameter.

Conclusions/action items: This image shows the dimensions of the extension piece modeled. The piece is universal for all users.

Velcro straps-10/28/21

VICTORIA HEILIGENTHAL - Oct 28, 2021, 2:40 PM CDT

Title: Velcro Straps

Date: 10/28/21

Content by: Victoria

Present: N/A

Goals: To find velcro straps for the attachment portion of the design

Content:

For the attachment piece of the mask, we will be using velcro straps that can be easily adjusted for the user. Below are some options we can consider.

VELCRO® Brand ONE WRAP® Fastener | HookandLoop.com

-This site shows that this product is appropriate for medical uses. It is inexpensive ($25 for 3/8 in) and the roll is really long (25 yards). We could cut different sizes from the roll that would provide a lot of flexibility to test multiple lengths. The site also says it has a shear strength of 23 PSI and a peel strength of 0.5 PIW. Made of nylon and polypropylene.

Velcro® Brand Cable Ties - 3/4 x 8", Black S-17102 - Uline

Velcro® Brand Cable Ties - 3/4 x 12", Black S-17898 - Uline

These straps are from the same company and are made of the same material, just in different sizes. These are normally used for cables and wires, so they are very strong. They are both inexpensive as well ($30-$44). The strong material would be good to ensure the velcro will not become loose during testing. Made of nylon and polypropylene.

Buy VELCRO® Brand One-Wrap® Tie Rolls Online

12ft x3/4 in straps. Site claims has been used for multiple medical devices. Adjustable and cut to length. Prices vary from $6-$10 depending on where you get them from.

Conclusions/action items: After researching, there are a lot of velcro strap products on the market that we could use. They are all relatively inexpensive and we could cut the straps to the length we need. The team just has to decide on what size slit we will be creating to determine the velcro width strap we will get.

Plastic Piece Dimensions-10/31/21

VICTORIA HEILIGENTHAL - Oct 31, 2021, 10:10 PM CDT

Title: Plastic Piece Dimensions

Date: 10/31/21

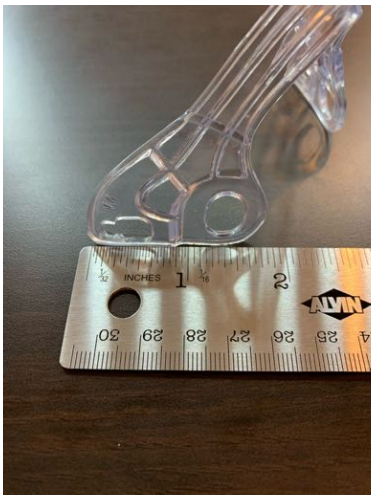
Content by: Victoria

Present: N/A

Goals: To document the dimensions of the current plastic piece from the mask

Content:

Side that attaches to mask: 2.875 in

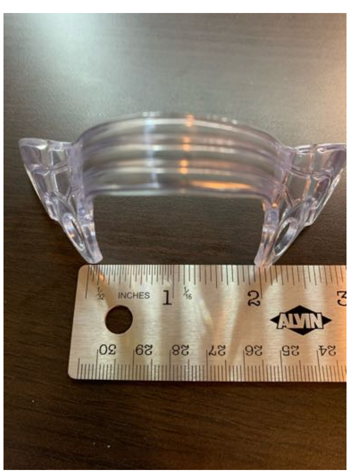


Width of piece: 4.125 in

Bridge of piece to end: 3.125 in

Diameter: 1.75 in

Distance between legs: 2 in



Conclusions/action items: These dimensions can be used for CAD sketches

Manufacturer Sketches-11/5/21

VICTORIA HEILIGENTHAL - Nov 05, 2021, 11:10 PM CDT

Title: Manufacturer Sketches

Date: 11/5/21

Content by: Victoria

Present: N/A

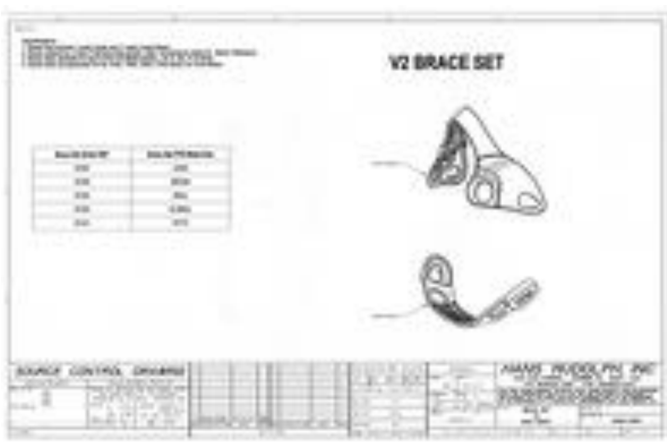
Goals: To add the sketches provided by the manufacturer.

Content:

Since we have not been able to easily obtain the 3D scans of the plastic pieces yet, we thought it would be a good idea to contact the mask manufacturer to see if they could give us their CAD files of the masks. I had reached out to someone at Hans Rudolph, the manufacturer of the masks used by JHT and although they could not provide us with the CAD files, we were provided some sketches of the masks and its components, including the plastic pieces. We also learned that the plastic brace pieces can be purchased for $20 each. This is good to know in case we ever need to get a new one. The sketches are attached below.

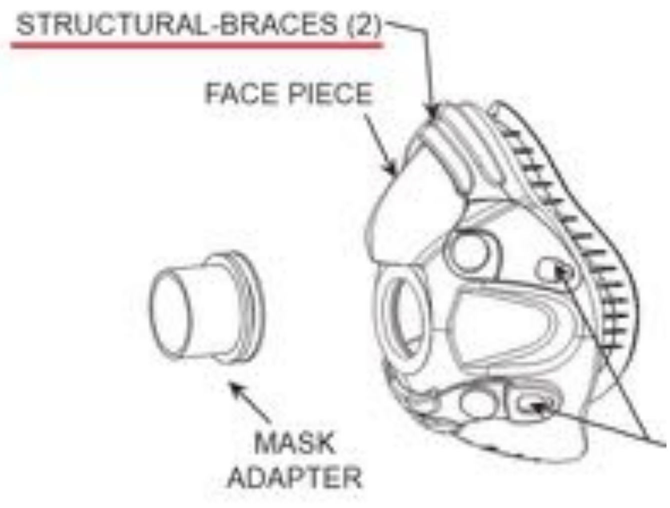
Conclusions/action items: These can be used in order to create our modeling.

VICTORIA HEILIGENTHAL - Nov 05, 2021, 11:12 PM CDT



Brace_Sets_DRAWING_s-201607_S_A_8334_.tif(229.6 KB) - download

VICTORIA HEILIGENTHAL - Nov 05, 2021, 11:12 PM CDT



DRAWING_ILLUSTRATING_structural_braces_8335_.PNG(157.3 KB) - download

Extension Piece-11/23/21

VICTORIA HEILIGENTHAL - Nov 23, 2021, 7:21 PM CST

Title: Extension Piece

Date: 11/23/21

Content by: Victoria

Present: N/A

Goals: To document the model of the extension piece

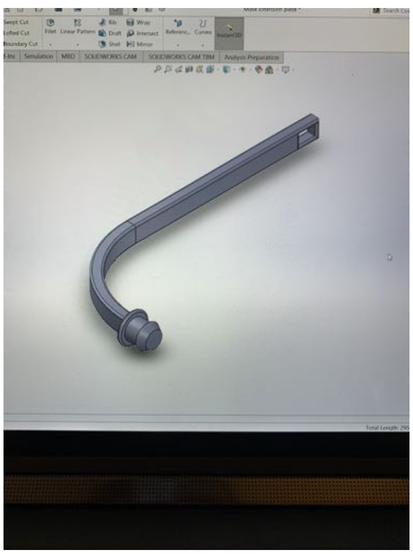
Content:

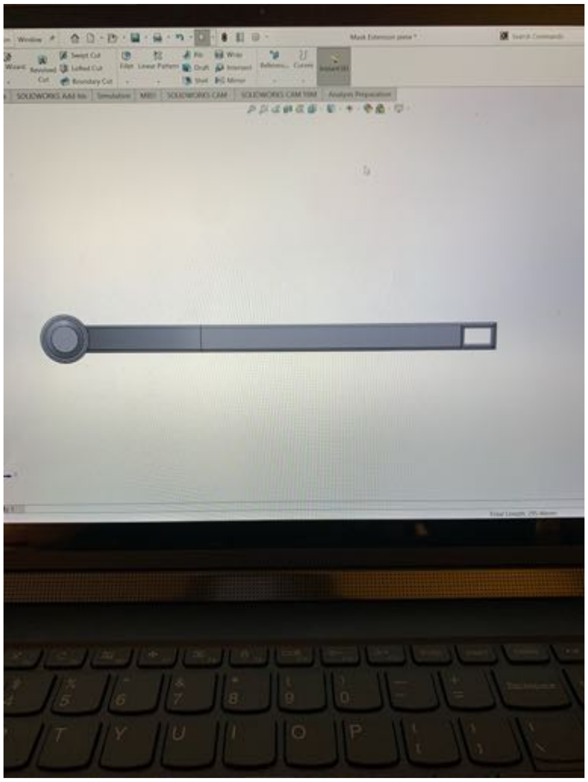
SolidWorks CAD Model:

-Shows slit where Velcro will be

-Shows angle turn to aim towards the user's glasses

-Shows how it will attach to the mask





Printed Version

Conclusions/action items: These pictures and models shows the extension piece. From here, the team can file down the piece to create a smoother finish and get ready for testing

Plastic Piece-11/23/21

VICTORIA HEILIGENTHAL - Nov 23, 2021, 7:29 PM CST

Title: Plastic piece

Date: 11/23/21

Content by: Victoria

Present: N/A

Goals: To document the plastic pieces from the mas

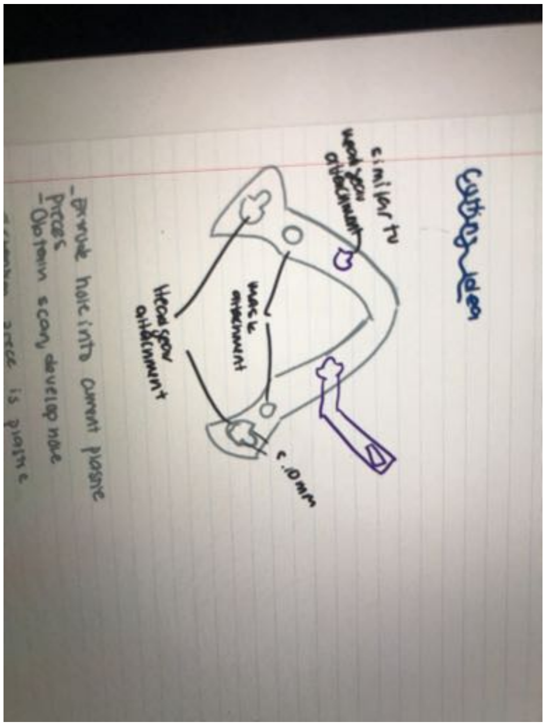
Content:

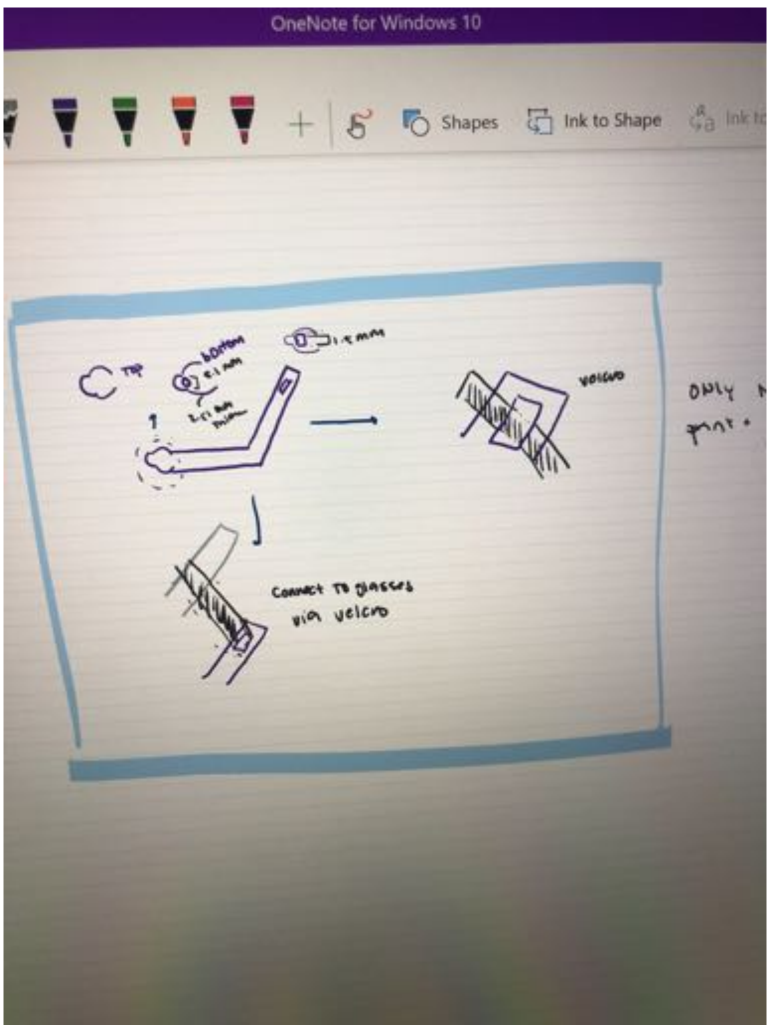
The team decided to 3D print the plastic piece from the mask from a 3D scan of the piece. This piece will allow the team to edit it and make changes rather than modifying the one on the mask from the client.

3D scanned model:

Inserted below

Sketches of plastic piece and extension piece:





Conclusions/action items: These images and files show the plastic piece of the mask for the final design

VICTORIA HEILIGENTHAL - Nov 23, 2021, 7:30 PM CST

,

Knauss_11_8_Medium.stl(119.2 MB) - download

VICTORIA HEILIGENTHAL - Nov 23, 2021, 7:32 PM CST

,

Knauss_11_8_Small.stl(119.2 MB) - download

Complete list of all components and materials-12/6/21

VICTORIA HEILIGENTHAL - Dec 06, 2021, 3:50 PM CST

VICTORIA HEILIGENTHAL - Dec 06, 2021, 4:07 PM CST

Title: Complete list of all components and materials

Date: 12/6/21

Content by: Victoria Heiligenthal

Present: N/A

Goals: To document the complete list of materials used for all components of the mask

Content:

Things used in additional team design:

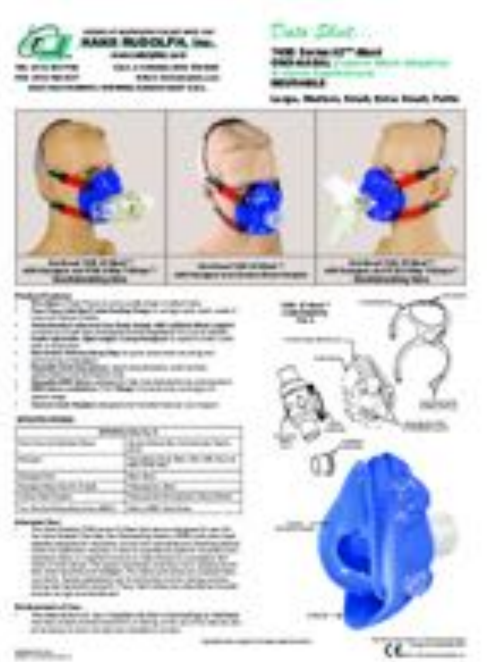
-Extension piece: PLA plastic (sturdy, tough plastic)
-Velcro strap (allow extension pieces to connect to legs of glasses securely)
-Structural top brace piece: resin (flexible plastic material that is similar to the current material used by the original mask)

Additional materials on mask that was not changed:
-Face piece: silicone rubber
-Headgear: polyurethane foam black, nylon UBL Gray and Nylon Fabric red
-Headgear hook: nylon
-Structural Brace piece: Polycarbonate Thermoplastic
-headgear strap clips: Polypropylene

The spec sheet of the mask manufacturer is also attached.

Conclusions/action items: The team can accurately explain how the mask was developed and the materials used for each component.

VICTORIA HEILIGENTHAL - Dec 06, 2021, 3:56 PM CST



face_mask_spec_sheet.pdf(1.5 MB) - download

9/14/2021 Why VO2 Mask?

RACHEL KRUEGER - Sep 14, 2021, 8:53 PM CDT

Title: Why use a VO2 mask?

Date: 9/14/2021

Content by: Rachel Krueger

Present: Rachel Krueger

Goals: Understand why athletes use VO2 masks, benefits.

Content:

Training Mask Benefits: About, Use, Safety, and More (healthline.com)

These masks stimulate conditions at higher altitudes to put the body under stresses similar to those they would experience during exercise at high altitudes.

Helps to achieve the same benefits of training as if you are actually at the high altitude.

While the mask is on, your body adapts to the reduced oxygen intake and the heart and lungs begin to work harder.

Benefit: when the mask is removed, your body is able to use oxygen more efficiently when normal oxygen levels are restored.

Benefit: trains your body to be able to run farther, jump higher, bike harder, etc.

The VO2 mask will help your body to maximize oxygen intake.

Conclusions/action items:

A VO2 mask can help your body acclimate to changing oxygen levels. More research is needed to determine whether these masks cause decrease in performance while training.

RACHEL KRUEGER - Oct 19, 2021, 5:23 PM CDT

Citation (IEEE):

[1] J. Larson, “Training mask benefits: About, use, safety, and more,” *Healthline*, 28-Oct-2020. [Online]. Available: https://www.healthline.com/health/training-mask-benefits#benefits. [Accessed: 14-Sep-2021].

9/14/2021 Working out in a mask

RACHEL KRUEGER - Sep 14, 2021, 9:05 PM CDT

Title: Working out in a mask - safe?

Date: 9/14/2021

Content by: Rachel Krueger

Present: Rachel Krueger

Goals: Understand whether or not working out in a mask is safe.

Content:

Running With Mask | How Does a Mask Affect Performance? (runnersworld.com)

While VO2 masks create a hypoxic environment to intentionally restrict the amount of oxygen in the air, the runner is not changing the oxygen saturation of the air using a normal face mask.

The runner is simply breathing in less of the air than they typically would when not wearing a mask.

Your lungs have to work harder to get the same amount of air that you're used to, which can strengthen the lungs.

It will also increase your heartrate, which will strengthen your diaphragm.

When the mask becomes damp, it will become less effective.

Over time, the runner will become adapted to breathing with a mask on and performance will likely increase when training resumes without a mask on.

Face masks don't hinder breathing during exercise, study finds -- ScienceDaily

Exercise performance and blood and muscle oxygen levels are not affected for healthy individuals wearing a mask during strenuous workouts.

Conclusions/action items:

Determine how VO2 masks differ in performance from regular surgical masks.

RACHEL KRUEGER - Oct 19, 2021, 5:26 PM CDT

Citations:

[1] E. Dibdin, “Running with a mask is hard, but can it improve my performance?,” *Runner's World*, 13-Mar-2021. [Online]. Available: https://www.runnersworld.com/training/a32380203/running-with-mask-impact-your-performance/.

[Accessed: 14-Sep-2021].

[2] “Face masks don't hinder breathing during exercise, study finds,” *ScienceDaily*, 05-Nov-2020. [Online]. Available: https://www.sciencedaily.com/releases/2020/11/201105112934.htm. [Accessed: 14-Sep-2021].

From 9/18/2021 Mask Filtration and Disinfection

RACHEL KRUEGER - Oct 08, 2021, 11:21 AM CDT

Title: Mask Filtration and Disinfection

Date: 10/8/2021, research from 9/18/2021

Content by: Rachel Krueger

Present: Rachel Krueger

Goals: Understand different materials effectiveness for filtration purposes and determine whether or not certain materials can undergo disinfection without damage to the material.

Content:

[EPA Researchers Test Effectiveness of Face Masks, Disinfection Methods Against COVID-19 | US EPA]

1. Both expired and sterilized N95 masks provided the same protection as new N95 masks.
    1. They had a filtration rate of 95%
2. surgical masks with ties provided 71.5% filtration
3. surgical masks with loops provided only 38.1% filtration
4. 3 layer knitted cotton mask blocked an average of 26.5% of particles in a chamber
5. washed, 2 layer woven nylon mask with a filter insert and metal nose bridge blocked 79% of particles
6. **As the fit improves, so does filtration efficiency**
7. Tested disinfection on N95 masks, protective suits, face shields, face covering, street clothes, etc.
    1. certain disinfection techniques work well without damaging the protection. Not universal, different techniques work best on different types of PPE.

Conclusions/action items:

Could be useful to know how different materials work in terms of filtration. Most useful to know that as fit improves, so does filtration efficiency. Use this information to design a good fit for the VO2 mask. Consider different disinfection techniques.

RACHEL KRUEGER - Oct 19, 2021, 5:28 PM CDT

Citation:

[1] *EPA*. [Online]. Available: https://www.epa.gov/sciencematters/epa-researchers-test-effectiveness-face-masks-disinfection-methods-against-covid-19. [Accessed: 18-Sep-2021].

From 10/1/2021 When does leakage occur

RACHEL KRUEGER - Oct 08, 2021, 11:42 AM CDT

Title: When Does Leakage Occur?

Date: 10/8/2021, research from 10/1/2021

Content by: Rachel Krueger

Present: Rachel Krueger

Goals: Understand what causes leakage with a breathing mask and how to best prevent it

Content:

Respirator Exhalation Valve Leakage. | Occupational Safety and Health Administration (osha.gov)

1. 3 potential sources of leakage: filter, face seal, exhalation valve
2. exhalation valves have to undergo leakage tests to prove they are adequate: exhalation valves subject to suction of 25mm water column height while in their normal operating position and leakage shall not exceed 30 mm per minute.
3. for a properly maintained exhalation valve, inward leakage is less than the allowable leakage.
4. ensure working properly by: inspect for defects, properly attached, no foreign materials

Conclusions/action items:

Consider these findings when changing aspects of the mask - when will it affect leakage?

RACHEL KRUEGER - Oct 19, 2021, 5:29 PM CDT

Citation:

[1] “Department of Labor Logo United Statesdepartment of Labor,” *Respirator Exhalation Valve Leakage. | Occupational Safety and Health Administration*. [Online]. Available: https://www.osha.gov/laws-regs/standardinterpretations/1994-05-25. [Accessed: 01-Oct-2021].

10/8/2021 Nose lengths

RACHEL KRUEGER - Oct 08, 2021, 11:51 AM CDT

Title: Nose Lengths

Date: 10/8/2021

Content by: Rachel Krueger

Present: Rachel Krueger

Goals: Get a general measurement of typical nose sizes

Content:

The average values of the nasal anthropometric measurements in 108 young Turkish males - PubMed (nih.gov)

1. 108 turkish males 18-30 years old (mean=22.31)
2. mean total length of nose was 56.92mm
3. mean nasal bridge length was 55.26mm
4. mean nasal bridge width was 29.74mm
5. mean width of nostril floor was 11.00mm
6. mean frontonasal angle was 134.96 degrees
7. mean nasolabial angle was 90.32 degrees

Conclusions/action items:

This information is useful when determining how much the team is able to lower the mask on the bridge of the nose. If we lower it too much, leakage will occur. Obviously this is a far too small sample size, but good start.

RACHEL KRUEGER - Oct 19, 2021, 5:30 PM CDT

Citation:

[1] Uzun A;Akbas H;Bilgic S;Emirzeoglu M;Bostanci O;Sahin B;Bek Y; "The average values of the nasal anthropometric measurements in 108 young Turkish males," *Auris, nasus, larynx*. [Online]. Available:

https://pubmed.ncbi.nlm.nih.gov/16039817/. [Accessed: 08-Oct-2021].

From 9/30/21 Applying chemistry

RACHEL KRUEGER - Oct 19, 2021, 6:01 PM CDT

Title: Applying Chemistry

Date: 9/30/2021

Content by: Rachel Krueger

Present: Rachel Krueger

Goals: Understand any chemistry the team must consider in order to avoid issues in compliance/testing/results

Content:

Link: [Silicone Safety: Risks, Exposure Sources, Is Silicone Toxic & More (healthline.com)](https://www.healthline.com/health/body-modification/is-silicone-toxic#bottom-line)

Citation: [1] E. Cirino, “Silicone safety: Risks, exposure sources, is silicone toxic & more,” *Healthline*, 27-Aug-2019. [Online]. Available: https://www.healthline.com/health/body-modification/is-silicone-toxic#bottom-line. [Accessed: 30-Sep-2021].

1. silicone is a lab made material that typically consists of: silicon, oxygen, carbon, and hydrogen
2. it is a chemically stable, flexible plastic
3. safe to use and generally not toxic
4. silicone is widely used for surgical implants, which means it is typically not harmful when in contact with the human body
5. some people can have a silicone-reactive disorder, but they are generally aware of the need to stay away from silicone based products

Conclusions/action items:

Silicone is used to mold the current mask, and seems like a relatively safe option for the new mask as well. There don't seem to be many adverse chemistry related issues that may arise while using silicone in contact with the skin.

10/19/2021 Needs of the Biomedical Problem

RACHEL KRUEGER - Oct 19, 2021, 9:16 PM CDT

Title: Needs of the biomedical problem

Date: 10/19/2021

Content by: Rachel Krueger

Present: Rachel Krueger

Goals: Understand why this problem needs to be solved, what impact it will have.

Content:

Link: Exercise Testing | Johns Hopkins Medicine

Citation:

[1] "Exercise testing: Johns Hopkins Medicine," *Exercise Testing* | *Johns Hopkins Medicine*, 23-Jun-2021. [Online]. Available: https://www.hopkinsmedicine.org/heart_vascular_institute/cardiology/cardiac-rehabilitation/exercise

testing.html#:~:text=A%20VO2%20max%20test%20is%20a%20maximal%20exercise,exercise.%20This%20is%20a%20gold-standard%20measurement%20of%20endurance. [Accessed: 19-Oct-2021].

1. VO2 max testing is a way to determine athletic performance.
2. it analyzes the participants expired air
3. it also measure ventilatory threshold
4. some benefits:
    1. Accurate measurement of current fitness
    2. Ability to design a more effective training program
    3. Evaluation of effectiveness of training programs
    4. Prediction of maximal steady-state running speed or cycling wattage
5. it is relatively inexpensive and noninvasive

VO2 max testing is obviously very beneficial to athletes and performance. Not being able to accommodate for participants with glasses puts them at a disadvantage, as they cannot have their performance evaluated. By allowing all users an equal and fair opportunity to access this testing, it will have a very positive impact on the athletic world.

Conclusions/action items:

Keep this goal in mind when progressing through the project to ensure inclusiveness for all.

From 10/11/2021 Broader Impact of the Problem and Solution

RACHEL KRUEGER - Oct 19, 2021, 9:20 PM CDT

Title: Broader impact of the problem and solution

Date: 10/11/2021

Content by: Rachel Krueger

Present: Rachel Krueger

Goals: Understand how the problem and solution impact the medical world.

Content:

The solution impacts the medical world because athletes will be able to test their performance, whether they wear glasses or not. They will be able to have access to a broader range of devices that are inclusive of all people. The solution will also reduce stress and anxiety in glasses wearers who use to do this testing without their glasses on. This was a stressful experience, given they had to do high intensity training activities without being able to see properly. This will increase the satisfaction of users, while also creating a better and more inclusive medical world.

Conclusions/action items:

Accessibility will need to be considered to ensure this product is still affordable as well.

9/14/2021 Competing Designs

RACHEL KRUEGER - Sep 14, 2021, 9:18 PM CDT

Title: Competing designs

Date: 9/14/2021

Content by: Rachel Krueger

Present: Rachel Krueger

Goals: List some of the competing designs and the pros/cons of them

Content:

VO2 Master Analyzer | VO2 Master

This VO2 mask is able to measure:

1. performance testing
2. resting metabolic testing

Benefits in this design:

1. no backpacks, cables, or hoses
2. no calibration syringes or gas tanks
3. validated against the gold standard
4. filters ensure sanitation between users
5. free mobile application for guided testing

image of the VO2 Master

CardioCoach VO2 Max Testing Equipment - KORR Medical Technologies

Measures:

1. VO2 max and sub max
2. AT, AeT, peak VO2
3. precise target heart rates
4. calories burned during exercise
5. barometric pressure, temperature, and humidity

Benefits:

1. simple user interface with wireless connections

2. results can be uploaded to the CardioCoach app to guide your client through workouts for cardio-strengthening, endurance, weight loss or other goals custom
3. independently validated at the University of Southern California and Oregon State University

Conclusions/action items:

Continue researching VO2 competitors and try integrating their benefits

RACHEL KRUEGER - Oct 19, 2021, 5:38 PM CDT

Citations:

[1] A. H. K. Montoye and R. Hinnen, “Vo2 master analyzer,” *VO2 Master*. [Online]. Available: https://vo2master.com/analyzer/. [Accessed: 14-Sep-2021].

[2] J. White, “Cardiocoach VO2 MAX testing equipment - KORR Medical Technologies,” *KORR Medical Technologies - Metabolic Rate Test Equipment*, 23-Aug-2013. [Online]. Available: https://korr.com/products/vo2-max-testing-system/. [Accessed: 14-Sep-2021].

10/8/2021 Equivalence Testing

RACHEL KRUEGER - Oct 08, 2021, 1:39 PM CDT

Title: Equivalence Testing

Date: 10/8/2021

Content by: Rachel Krueger

Present: Rachel Krueger

Goals: Understand equivalence testing and how we can apply it to our project.

Content:

A Primer on the Use of Equivalence Testing for Evaluating Measurement Agreement (nih.gov)

-Equivalence testing is better to use when determining the validity of physical activity.
-Bland Altman method: enables error and bias to be visualized across a range of scores
* does not enable the degree of equivalence to be quantified
* researchers use standard statistical tests of mean difference - doesn't determine equivalency

Traditional approach: null and alternative hypotheses are reversed.
* null hypothesis is now that the two methods are not equivalent
* so, if the difference is small, the null hypothesis is rejected in favor of the alternative = equivalence
* user must define an equivalence region

confidence interval method: comparing equivalence region and confidence interval.
* null hypothesis is rejected if the 100(1-2(alpha))% lies directly within the confidence interval.

Conclusions/action items:

Consider the different methods in terms of our project and decide which one best fits our description.

RACHEL KRUEGER - Oct 19, 2021, 5:32 PM CDT

Citation:

[1] P. M. Dixon, P. F. Saint-Maurice, Y. Kim, P. Hibbing, Y. Bai, and G. J. Welk, “A primer on the use of equivalence testing for evaluating measurement agreement,” *Medicine and science in sports and exercise*, Apr-2018. [Online].

Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5856600/. [Accessed: 08-Oct-2021].

10/8/2021 3D printing and molding

RACHEL KRUEGER - Oct 08, 2021, 1:58 PM CDT

Title: 3D printing and molding

Date: 10/8/2021

Content by: Rachel Krueger

Present: Rachel Krueger

Goals: Determine best ways to obtain a physical prototype of our mask

Content:

Makerspace:

1. 3D printer options: [3D Printers – UW Makerspace – UW–Madison (wisc.edu)]
    1. Ultimaker (FFF) - fused filament fabrication. Flexible material options = arkema 3DXFLEX TPE, DSM arnitel, Jabil TPE, lubrizol estane TPU, Ultimaker TPU
    2. Formlab form 2 and 3s - high performance, high impact materials
    3. formlab fuse 1 - flexible and elastic materials. can be produced without molding. probably our best option to meet our needs.

3D printing vs injection molding: [3D Printing vs Injection Molding: Know The Difference - Total 3D Printing]

1. 3D printing is more expensive, whereas injection molding is a cheaper variant for bigger produce.
2. 3D printing is smaller, whereas injection molding machines are quieter and faster.
3. 3D printing allows you to make changes at any stage of the production process, whereas with injection molding you can't make changes during the producing process.
4. injection molding pros: repeatability, finish, mass production, bigger parts
5. injection molding cons: scrap rates, up front costs, time, difficulty making changes, uniform wall thickness,
6. 3D printing pros: range of accessibility, adjustments allowed, price, range of materials
7. 3D printing cons: size, scalability,

Conclusions/action items:

3D printing is our best option given our product, time, and budget.

RACHEL KRUEGER - Oct 19, 2021, 5:35 PM CDT

Citations:

[1] “3D printers,” *UW Makerspace*. [Online]. Available: https://making.engr.wisc.edu/3d-printers-2/. [Accessed: 08-Oct-2021].

[2] M. Griffin, “3D printing vs injection molding: Know the difference,” *Total 3D Printing*, 15-Aug-2020. [Online]. Available: https://total3dprinting.org/3d-printing-vs-injection

molding/#:~:text=The%20main%20differences%20between%203D%20printing%20vs%20Injection,you%20can%E2%80%99t%20make%20changes%20during%20the%20producing%20process. [Accessed: 08-Oct-2021].

10/19/21 Considering Engineering Principles

RACHEL KRUEGER - Oct 19, 2021, 9:37 PM CDT

Title: Considering engineering principles

Date: 10/19/2021

Content by: Rachel Krueger

Present: Rachel Krueger

Goals: Consider engineering principles in terms of the project.

Content:

1. Biomechanics: the study of the mechanical laws relating to the movement or structure of living organisms.
   1. this project is related to biomechanics, so it is important to understand what it is.
2. frictional force: force resisting the relative motion of solid surfaces, fluid layers, and material elements sliding against each other
   1. important when considering the material of the mask - have to make sure there is enough frictional force to keep it in place
3. ultimate strength: is the maximum stress that a material can withstand while being stretched or pulled before breaking.
   1. need to have a relatively high strength to be able to withstand these high intensity activities
4. elasticity: the ability of an object or material to resume its normal shape after being stretched or compressed; stretchiness.
   1. material needs to be elastic to be able to fit all different face shapes and stresses during exercise

Conclusions/action items:

These are the most important engineering principles relating to our project that we need to consider.

From 10/8/2021 Applying Equations and Statistics

RACHEL KRUEGER - Oct 19, 2021, 9:52 PM CDT

Title: Equations and statistics

Date: 10/8/2021

Content by: Rachel Krueger

Present: Rachel Krueger

Goals: List equations and statistics that are relevant to the project.

Content:

Link: [VO2 Max Calculator - (trailrunnerworld.com)](https://www.trailrunnerworld.com/vo2-max-calculator/)

Citation: [1] A. Botterill, "Vo2 Max Calculator," *Trail Runner World* -, 15-Feb-2021. [Online]. Available: https://www.trailrunnerworld.com/vo2-max-calculator/. [Accessed: 08-Oct-2021].

for more information regarding statistics most likely being used in our project, see entry on equivalence testing

Equations relevant to VO2 testing:

1. calculate resting heartrate: beats/60seconds at rest
2. calculate maximum heartrate: beats/60seconds after high intensity exercise
3. VO2 Max = 15.3 * (HR max/HR rest)
4. Cooper test = VO2 max = distance - 504.9/44.73 (have to run for 12 minutes, measure distance in meters)
5. 1 mile walk test (using age, body weight, heart rate) = VO2 max = 132.853 - 0.0769 * body weight - 0.3877 * age - 3.2649 * time - 0.1565 * HR + constant (6.153 for males, 0 for females)

Conclusions/action items:

These equations are helpful and useful to be able to test our own VO2, get a good idea of results we should expect and be able to compare to, prior to go to the biomechanics lab.

From 10/8/2021 Design Constraints

RACHEL KRUEGER - Oct 19, 2021, 9:59 PM CDT

Title: Design constraints

Date: 10/8/2021

Content by: Rachel Krueger

Present: Rachel Krueger

Goals: Outline design constraints for our project.

Content:

1. Budget of $400, cannot be too elaborate
2. time constraint - one semester to complete
3. access to many different 3D printing options, have to consider which are readily available and which we need to allow time for
4. leakage of air must be limited - cannot design with any holes or too much flexibility
5. must be practical and user friendly - cannot have too complex of a design simply to fix the issue
6. must be reusable - use materials that are compatible with cleaning and disinfectants
7. must also be able to withstand many testing exercises - durable materials

Conclusions/action items:

consider these constrains when finalizing the design.

From 10/8/2021 Design Ideas and Alternatives

RACHEL KRUEGER - Oct 19, 2021, 10:08 PM CDT

Title: Design ideas and alternatives

Date: 10/8/2021

Content by: Rachel Krueger

Present: Rachel Krueger

Goals: Outline sketches and designs.

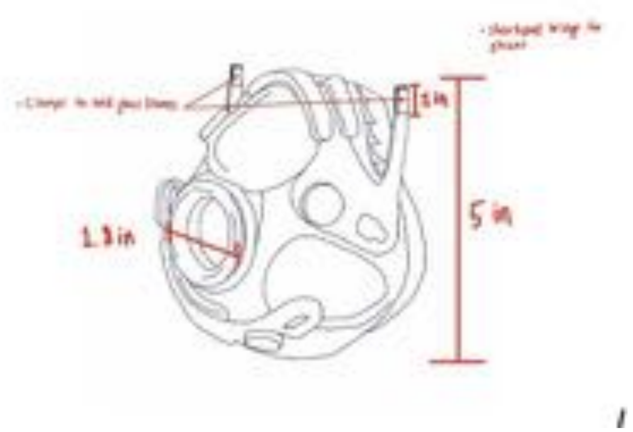
Content:

See accompanying captions for sketch explanations.

Conclusions/action items:

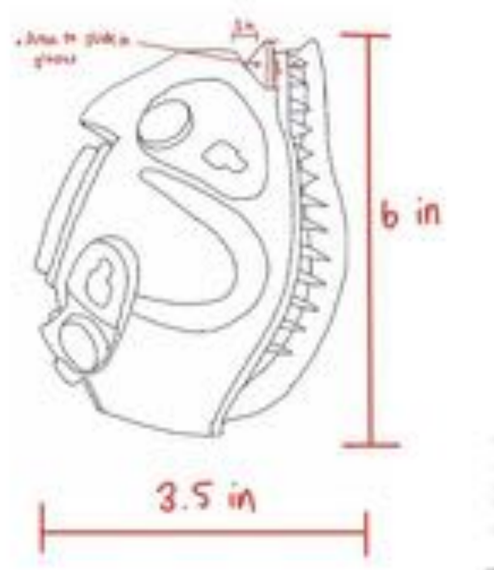
Move forward with fabrication of the final design.

RACHEL KRUEGER - Oct 19, 2021, 10:05 PM CDT



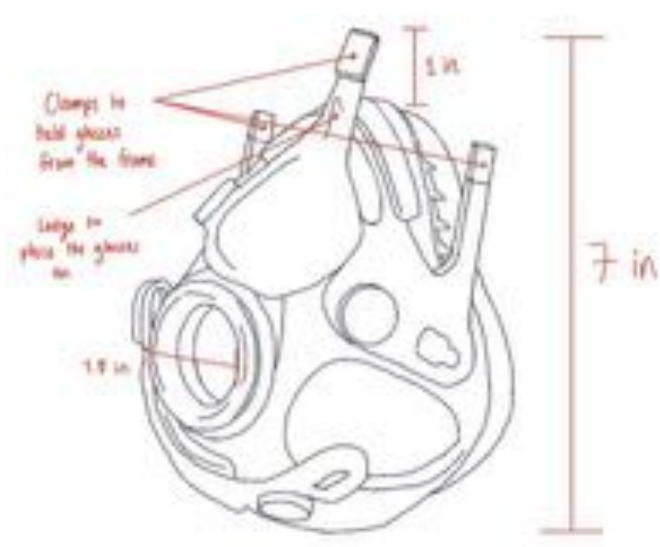
clips_and_lower_bridge.JPG(31.3 KB) - download This design lowers the area that covers the bridge of the nose by one inch to allow glasses to comfortably fit on the nose without interference from the mask. Two clips are attached to the mask, allowing the mask to secure the glasses in place. This prevents the mask from damaging the glasses during high intensity activities. The clips will latch onto the glasses legs, firmly holding them up.

RACHEL KRUEGER - Oct 19, 2021, 10:06 PM CDT



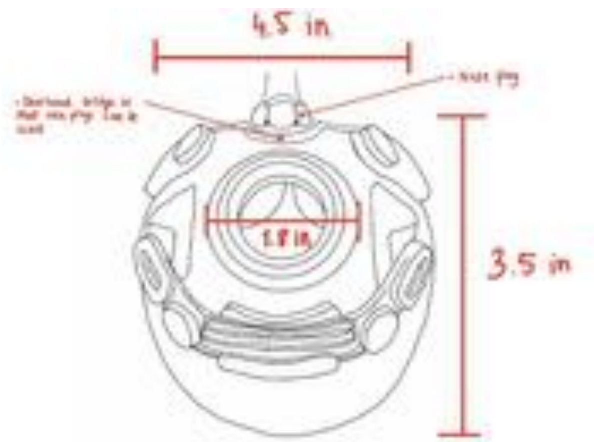
divot.JPG(32.4 KB) - download This design allows the bridge of the glasses to fit into a 1 inch by 1 inch trench incorporated on the mask. All other aspects of the mask will remain the same as the current mask.

RACHEL KRUEGER - Oct 19, 2021, 10:06 PM CDT



final_proposed_design.JPG(34.1 KB) - download The proposed final design contains aspects of design 1 and 2. In terms of design 1, the final design will have two clips on the side that attach the glasses legs to the mask. In replace of the divot, but in hopes to keep the general idea of design 2, the team is adding a third clip that will secure the center of the glasses to the mask as well. There will be a “ledge” on the center clip that will ensure the glasses do not slip out of place and will minimize vertical movement of the glasses.

RACHEL KRUEGER - Oct 19, 2021, 10:07 PM CDT



nose_clip_and_mouth_piece.JPG(36.2 KB) - download A nose plug clip is applied to the external part of the user's nose and does not allow air flow into or out of the nose. All air flow will be filtered and collected through the mouth through a mouthpiece. The mask is shortened to 3.5 inches and the top of the mask rests in between the bottom of the nose and the upper lips of the user.

RACHEL KRUEGER - Oct 19, 2021, 10:09 PM CDT

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

design_matrix.JPG(51.8 KB) - download The teams finalized design matrix.

10/19/2021 Recommended Solution/Final Design

RACHEL KRUEGER - Oct 19, 2021, 10:11 PM CDT

Title: Final design

Date: 10/19/2021

Content by: Rachel Krueger

Present: Rachel Krueger

Goals: Outline the team's final design

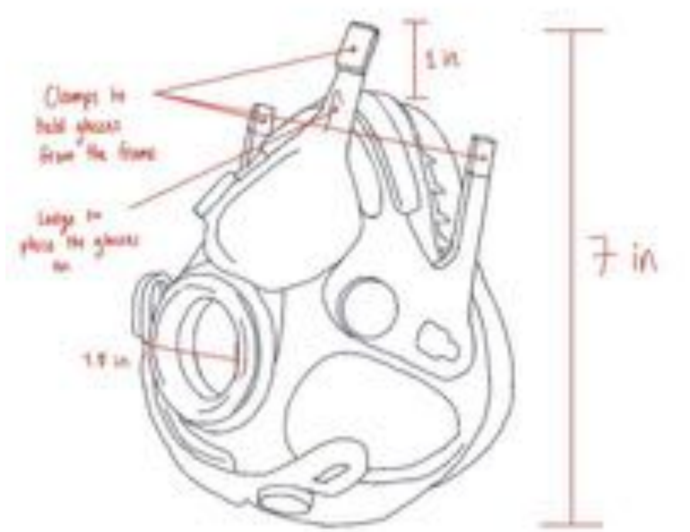
Content:

The proposed final design contains aspects of preliminary design 1 and 2. In terms of design 1, the final design will have two clips on the side that attach the glasses legs to the mask. In replace of the divot, but in hopes to keep the general idea of design 2, the team is adding a third clip that will secure the center of the glasses to the mask as well. There will be a “ledge” on the center clip that will ensure the glasses do not slip out of place and will minimize vertical movement of the glasses. The mask will have the same dimensions as the original mask, but three clips will be added. This will ensure that the glasses are able to fit, stay in place, and the mask is still able to function properly.

Conclusions/action items:

Make any changes to the final design that arise as the team moves into the fabrication process.

RACHEL KRUEGER - Oct 19, 2021, 10:11 PM CDT



final_proposed_design.JPG(34.1 KB) - download The final proposed design decided on by the team.

From 10/11/2021 Codes and Standards

RACHEL KRUEGER - Oct 19, 2021, 10:19 PM CDT

Title: Codes and standards

Date: 10/11/2021

Content by: Rachel Krueger

Present: Rachel Krueger

Goals: identify any codes or standards to consider

Content:

the team was given a product from the client that already is used and works properly. So, all codes and standards regarding the mask itself have been considered.

After doing research, there are currently no standards for glasses clips that need to be considered.

Ethically, the team must consider all face shapes and sizes, regardless or age, gender, orientation, weight, race, etc.

It is unethical to use toxic or harmful materials when fabricating the design, as it will be used in contact with human skin.

Conclusions/action items:

Make sure the mask is consistent with these guidelines and inclusiveness.

10/19/2021 Experimental Results

RACHEL KRUEGER - Oct 19, 2021, 10:23 PM CDT

Title: Experimental results

Date: 10/19/2021

Content by: Rachel Krueger

Present: Rachel Krueger

Goals: Outline experimental results

Content:

The team has not done any testing yet, so this will be updated once the final design is tested. This is also where graphical presentations will come in.

Conclusions/action items:

Update as results are evaluated.

From 10/24/2021 Glasses clips

RACHEL KRUEGER - Dec 01, 2021, 3:42 PM CST

Title: Glasses clips ideas

Date: 10/24/2021

Content by: Rachel Krueger

Present: Rachel Krueger

Goals: Research potential glasses clips we could use to attach to the extension piece.

Content:

Our team is planning on creating some sort of extension piece that will secure the glasses to the face mask.

The piece will likely be attached to the clear plastic piece on the upper portion of the mask.

The piece needs to be sturdy enough to hold the glasses firmly without causing discomfort or vision interference.

The piece needs to be lightweight so as to not add too much excess weight on to the mask.

The piece needs to allow users to wear glasses during activity.

some possible ideas are below:

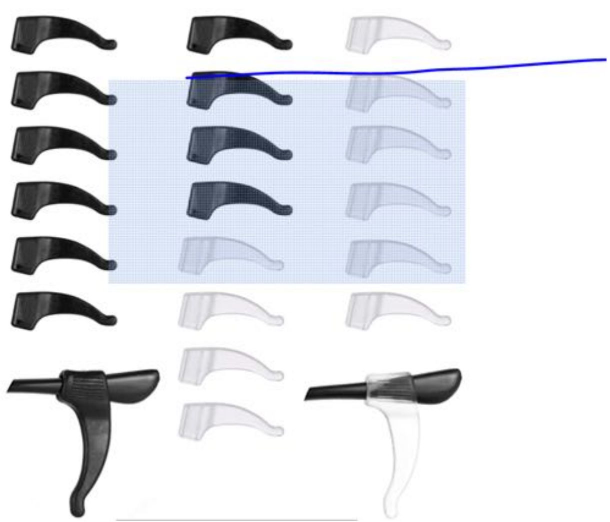


Figure: Clips that attach to end of legs. Can have extension piece grab the bottom of the clip. Goes behind the ear: eliminates vision obstruction.

Figure: Attach to legs. Straps could attach to mask. Would not be able to be firmly secured due to elasticity.

Conclusions/action items:

Proposed idea: 3D print extension piece with a slit at top to insert velcro and allow velcro to securely wrap around the legs.

From 11/2/2021 3D printing plastics

RACHEL KRUEGER - Dec 01, 2021, 3:52 PM CST

Title: 3D printing plastics

Date: 11/2/2021

Content by: Rachel Krueger

Present: Rachel Krueger

Goals: Understand which plastic would be best

Content:

We will most likely print on the ultimaker printer at the makerspace. The widest material choice on the market | Ultimaker

1. PETG: multicolor, easy, tough, chemical resistant, temperature resistant, wear resistant
2. PLA: easy, high stiffness, high strength, multicolor
3. nylon: tough, wear resistant, low friction
4. PVA: support material, water-soluble
5. breakaway: support material, easy
6. CPE: high strength, multicolor, translucent

Conclusions/action items:

It seems that PETG, PLA, or nylon are our best options. PLA is the most practical in terms of price, reliability, and availability.

12/10/2021 Testing

RACHEL KRUEGER - Dec 13, 2021, 12:00 PM CST

Title: Testing Documentation

Date: 12/10/2021

Content by: Rachel Krueger

Present: All except Tommy

Goals: Complete testing of final device.

Content:

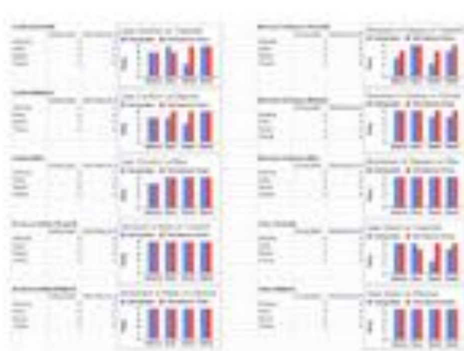
See attachments for testing outline and results.

Conclusions/action items: Determine how well the results support out desired outcomes.

RACHEL KRUEGER - Dec 10, 2021, 5:34 PM CST

Test_outline_-_Johnson_Health_Tech.pdf(90.7 KB) - download Figure: Testing outline

RACHEL KRUEGER - Dec 10, 2021, 5:38 PM CST



testing_-_Bar_Graphs.pdf(376.1 KB) - download Figure: Testing Results

RACHEL KRUEGER - Dec 10, 2021, 5:38 PM CST

testing_-_Original_Mask.pdf(44.2 KB) - download Figure: Testing Results

RACHEL KRUEGER - Dec 10, 2021, 5:38 PM CST

testing_-_Our_mask.pdf(40.9 KB) - download Figure: Testing Results

RACHEL KRUEGER - Dec 10, 2021, 5:38 PM CST

testing_-_Wilcoxon_Signed_Rank_Test_Analysis___Sign_Test.pdf(78.6 KB) - download Figure: Testing Results

12/13/2021 Testing Analysis of statistics

RACHEL KRUEGER - Dec 13, 2021, 12:06 PM CST

Title: Testing analysis of statistics

Date: 12/13/2021

Content by: Rachel Krueger - from final report

Present: N/A

Goals: Outline how we analyzed/collected results and the appropriate statistical analysis.

Content:

Initially, the team was planning to conduct an equivalence test between the design developed and the masks currently used by Johnson Health Tech to show the new design would still produce equivalent VO_2 max measurements while also allowing subjects to wear glasses during testing. These tests would have been carried out in the biomechanics lab at Johnson Health Tech under their protocols and procedures [18, 19]. Equivalence and noninferiority analysis tests and calculations would have been carried out to show the similarities in data between both masks. The equivalence test would have shown that if the VO_2 max values were within an equivalence margin, then the values would be considered "close enough" to be equivalent. The inferiority test also would utilize the equivalence margin to state that data from one mask was not inferior or superior to the other. These tests would have helped to ensure the team's mask design did not compromise comfort for accuracy of VO_2 max measurements. However, since the team is not changing the design on the mask itself but rather adding a component outside of the mask, the client preferred functional testing over equivalency testing.

In order to test the effectiveness of the mask design, the team completed functional testing of the design. Each test team member completed three, 5 minute aerobic exercise tests while wearing the VO_2 mask designed by the team. These aerobic exercises were biking, running on a treadmill, and using an elliptical. This testing was completed at the Nicholas Recreation Center at UW-Madison. The difficulty of the test was determined by the subject at a level they were comfortably challenged at to simulate the environment during a VO_2 max test. Post-test questions were asked to gain the subject's opinions and experiences during testing. The subjects provided a ranked response from 1-5 based on the level that best matched their opinions and experiences, one indicating a poor performance of the mask and five representing a comfortable experience. By using a ranking system, uniformity across all test subjects was maintained to eliminate objectivity for adequate data analysis. Any comments from the subject were also collected for each exercise. Pre-testing procedures, like measuring the subject's glasses, collecting demographic information, and ensuring the subject understood the tasks to perform, took place to ensure each subject completed the same testing process to provide the most reliable results. A source of error from testing was not conducting quantitative tests for the criteria. Alternative testing techniques could have been explored to collect quantitative data over the qualitative data that was collected to meet each criteria. For example, a video of the glasses on the user could have been taken during each test to measure the vertical excursion of them during testing, satisfying the movement of the glasses criteria category. However, it would have been difficult to quantitatively assess the other criteria using alternative testing methods.

A statistical analysis was conducted to provide quantitative outcomes for the collected qualitative data. This analysis, further discussed in the results section of the report, was chosen to help the team determine if the design met the needs of the client. With the new extension pieces added to the original design, it was expected that the rankings for each criteria would improve from the original design to the design with the extension pieces, showing the design was successful.

By completing this testing, the design proved to meet most of the client requirements. The mask design was shown to allow users to comfortably wear glasses during testing, was practical and user friendly, was reusable with cleaning, and was under the production budget. Although the requirements of preventing air leakage, withstanding testing for 20 minutes, and operational during intense aerobic activities were not fully met during the functional testing conducted, it can be assumed that the mask would meet these criteria as well as it showed to meet them over a smaller period of time.

Wilcoxon Signed Rank Test Description: The null hypothesis says that the median of group one is equal to the median of group two. The alternative hypothesis says that the two medians are different. Absolute differences are ranked from least to greatest in ascending order. The rank awarded to tied differences is the average of the ranks associated with those numbers. For example, if there are three differences of 1 tied for rank 1, the rank awarded to each would be the average of 1, 2, and 3 → 2. T+ is the sum of the ranks for values with positive differences, and T- is the sum of the ranks for values with negative differences. The lesser of these two numbers is used as the test statistic. The critical value/statistic is given in a table based on the significance level and sample size. The test statistic is then compared to the critical value. If the test statistic is less than the critical value, then there is a significant difference between the two medians (reject the null hypothesis).
https://www.statisticshowto.com/wilcoxon-signed-rank-test/

Sign Test Description: This test is very similar to the Wilcoxon Signed Rank Test. The null hypothesis and alternative hypothesis are the same. No ranks are assigned, and results are based solely on whether each calculated difference is positive or negative. Find the p-value from a binomial distribution table and compare it to the significance level to determine whether to reject or fail to reject the null hypothesis.
https://www.statisticshowto.com/sign-test/

Conclusions/action items: Use the statistical analysis tool on a bigger sample size.

12/13/2021 Complete final design

RACHEL KRUEGER - Dec 13, 2021, 12:08 PM CST

Title: Complete final design

Date: 12/13/2021

Content by: Rachel Krueger

Present: Rachel Krueger

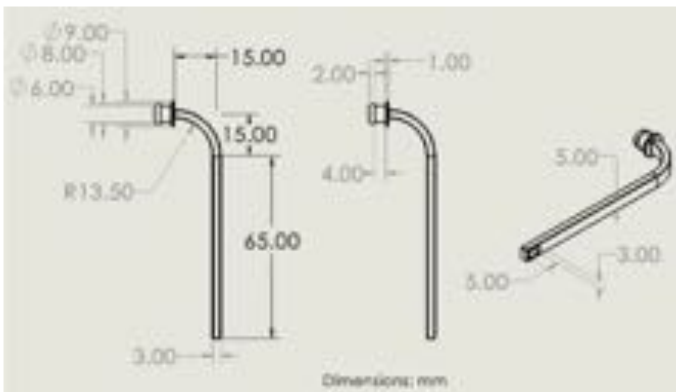
Goals: Show models of the final design.

Content:

See attachment for solidworks models and drawings.

Conclusions/action items: The final design was printed using the solidworks models.

RACHEL KRUEGER - Dec 13, 2021, 12:10 PM CST



Drawing_of_extension_piece.JPG(29.1 KB) - download Figure: Drawings and pictures of final model

RACHEL KRUEGER - Dec 13, 2021, 12:10 PM CST

extension_2.jpg(982.2 KB) - download Figure: Drawings and pictures of final model

RACHEL KRUEGER - Dec 13, 2021, 12:10 PM CST

,

final_mask_front_view.jpg(1.5 MB) - download Figure: Drawings and pictures of final model

RACHEL KRUEGER - Dec 13, 2021, 12:10 PM CST

,

solidworks.JPG(22.1 KB) - download Figure: Drawings and pictures of final model

3/14/2021 Biosafety and Chemical training

RACHEL KRUEGER - Mar 24, 2021, 8:42 PM CDT

Title: Biosafety and chemical training

Date: 3/14/2021

Content by: Rachel Krueger

Present: Rachel Krueger

Goals: Show documentation of completed trainings.

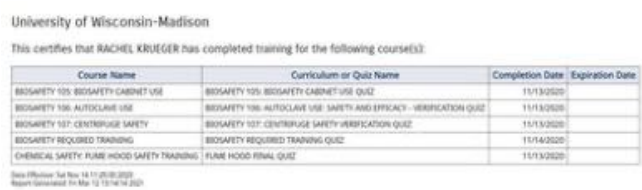
Content:

See attachments for proof of training completion.

Conclusions/action items:

Continue to be trained in other sections throughout this course and in the BME department to expand my knowledge and abilities.

RACHEL KRUEGER - Mar 24, 2021, 8:43 PM CDT



University of Wisconsin-Madison

This certifies that RACHEL KRUEGER has completed training for the following course(s):

Course Name	Curriculum or Quiz Name	Completion Date	Expiration Date
BIOSAFETY 105: BIOSAFETY CABINET USE	BIOSAFETY 105: BIOSAFETY CABINET USE QUIZ	11/13/2020	
BIOSAFETY 106: AUTOCLAVE USE	BIOSAFETY 106: AUTOCLAVE USE: SAFETY AND EFFICACY - VERIFICATION QUIZ	11/13/2020	
BIOSAFETY 107: CENTRIFUGE SAFETY	BIOSAFETY 107: CENTRIFUGE SAFETY VERIFICATION QUIZ	11/13/2020	
BIOSAFETY REQUIRED TRAINING	BIOSAFETY REQUIRED TRAINING QUIZ	11/14/2020	
CHEMICAL SAFETY: FUME HOOD SAFETY TRAINING	FUME HOOD FINAL QUIZ	11/13/2020	

Training.JPG(153.4 KB) - download Training documentation to show completion of required trainings.

RACHEL KRUEGER - Apr 29, 2021, 1:03 PM CDT

University of Wisconsin-Madison

This certifies that RACHEL KRUEGER has completed training for the following course(s):

Course Name	Curriculum or Quiz Name	Completion Date	Expiration Date
BIOSAFETY 105: BIOSAFETY CABINET USE	BIOSAFETY 105: BIOSAFETY CABINET USE QUIZ	11/13/2020	
BIOSAFETY 106: AUTOCLAVE USE	BIOSAFETY 106: AUTOCLAVE USE: SAFETY AND EFFICACY - VERIFICATION QUIZ	11/13/2020	
BIOSAFETY 107: CENTRIFUGE SAFETY	BIOSAFETY 107: CENTRIFUGE SAFETY VERIFICATION QUIZ	11/13/2020	
BIOSAFETY REQUIRED TRAINING	BIOSAFETY REQUIRED TRAINING QUIZ	11/14/2020	
CHEMICAL SAFETY: FUME HOOD SAFETY TRAINING	FUME HOOD FINAL QUIZ	11/13/2020	
CHEMICAL SAFETY: THE OSHA LAB STANDARD	FINAL QUIZ	4/15/2021	

Capture.JPG(165.3 KB) - download Updated chemical safety training

Green Permit

RACHEL KRUEGER - Feb 20, 2021, 12:51 PM CST

Green_Permit.PNG(144.4 KB) - download

RACHEL KRUEGER - Mar 25, 2021, 1:01 PM CDT

Image caption: Image showing proof of obtaining a green permit.

RACHEL KRUEGER - Feb 20, 2021, 12:52 PM CST

Title: Green Permit

Date: 2/20/2021

Content by: Rachel Krueger

Present: Rachel Krueger

Goals: Show proof of documentation of green permit.

Content:

Reference attachment

Conclusions/action items:

Obtain any other permits I made need in the future to complete my project.

9/13/2021 - UVA School of Medicine VO2 Max Testing Background

JAKOB KNAUSS - Sep 13, 2021, 4:04 PM CDT

Title: UVA School of Medicine VO2 Max Testing Background

Date: 09/13/2021

Content by: Jakob Knauss

Present: N/A

Goals: Gain background knowledge on the mechanics and purpose of VO2 max testing.

Content:

What is VO2 max?

- measuring maximal oxygen consumption
- maximum amount of oxygen that an individual can utilize during intense or maximal exercise
- generally considered the best indicator of cardiovascular fitness and aerobic endurance
- more oxygen used during high level exercise = more energy a person can produce
- gold standard for determining cardiorespiratory fitness because the muscles need oxygen for prolonged aerobic exercise, and the heart must pump adequate amounts of blood through the circulation to meet the demands of aerobic exercise

Measuring VO2 max

- using a face mask, the volume and gas concentrations of inspired and expired air can be directly measured
- used in research, very accurate
- test involves exercising on treadmill or bike at an intensity that increases every few minutes until exhaustion, designed to achieve a maximal effort
- maximal heart rate is also obtained, can be used along with rest heart rate to develop more precise target heart rate range (more accurate than age-predicted equations)
- determines current fitness level and how subject can use information to improve fitness

Figure 1: Subject participating in VO2 max testing on a bike.

Link: https://med.virginia.edu/exercise-physiology-core-laboratory/fitness-assessment-for-community-members/vo2-max-testing/

Citation:

"VO2 Max Testing." University of Virginia School of Medicine. https://med.virginia.edu/exercise-physiology-core-laboratory/fitness-assessment-for-community-members/vo2-max-testing/ (accessed September 13, 2021).

Conclusions/action items:

- continue reviewing other sources to better understand how the oxygen usage is measured and how the results of this testing are used to improved fitness in athletes

9/13/2021 - Healthline VO2 Max Testing Background

JAKOB KNAUSS - Sep 13, 2021, 4:01 PM CDT

Title: Healthline VO2 Max Testing Background

Date: 09/13/2021

Content by: Jakob Knauss

Present: N/A

Goals: Gain background knowledge on how VO2 max is measured and the benefits of VO2 max testing.

Content:

What is VO2 max?

- VO2 max = how much oxygen your body can absorb and use during exercise
- sometimes called oxygen uptake
- maximum rate of oxygen your body is able to use during exercise
- oxygen is a critical ingredient in the respiratory process involved in breathing
    - inhale oxygen --> produce ATP (energy) --> exhale CO2
- greater VO2 max --> more oxygen consumption --> more effective use of oxygen to produce max amount of ATP energy --> body can handle aerobic fitness activities that require a lot of oxygen intake (running, swimming, cardio)
- a high VO2 max can be a good predictor of athletic performance
- can be used as an indicator or benchmark to track athletic progress

How is VO2 max measured?

- conducted in medical facility (lab, hospital) by doctor, cardiologist, fitness specialist
- higher fitness levels: Astrand treadmill test, 2.4 km run test, multistage bleep test
- lower fitness levels: Cooper 1.5-mile walk-run test, treadmill test, compare results to average results from others

What's considered a 'good' VO2 max?

- depends on age, gender, fitness level, elevation

How can you increase your VO2 max?

- VO2 max typically declines with age
- high-intensity interval training (HIIT)
- switch up aerobic activities in a single workout (cycling, swimming, running)

Why increase your VO2 max?

- increased VO2 max = live longer!
- less exhausted doing activities like climbing stairs
- reduced stress levels
- boosted immune system, get sick less often

Takeaway

- VO2 max is a good benchmark for measuring aerobic fitness levels
- also strong predictor of quality of life as you age

Link: https://www.healthline.com/health/vo2-max

Citation:

T. Jewell. "Everything to Know About VO2 Max." Healthline. https://www.healthline.com/health/vo2-max (accessed September 13, 2021).

Conclusions/action items:

- find some research articles that demonstrate how this testing is used in research
- look into different VO2 mask designs

9/15/2021 - UC Davis Sports Medicine Health VO2 Max Testing Background

JAKOB KNAUSS - Sep 15, 2021, 12:29 PM CDT

Title: UC Davis Sports Medicine VO2 Max Testing Background

Date: 09/15/2021

Content by: Jakob Knauss

Present: N/A

Goals: Understand the physiology behind VO2max testing.

Content:

What is aerobic fitness?

- aka cardiovascular endurance
- body's ability to deliver oxygen to your muscles, allowing muscles to do work
- "The lungs take in oxygen from the air we breathe where it gets perfused into the blood stream; the heart and blood vessels deliver it into the working muscles; and the skeletal muscles utilize that oxygen to execute muscular contractions and produce work."
- goal of the test is to measure the efficiency of these physiological functions
- VO2 is expressed in milliliters of oxygen consumed per minute, adjusted for body weight in kilograms is ml/kg/min
- factors that can influence VO2max: heredity, training, age, gender, body composition
- declines with age (about 2% per year after age 30), males have greater oxygen consumption value than females
- "gold standard" measure of overall fitness

How is aerobic fitness assessed?

- gradually increased workload until maximum level is reached
  - heart rate, oxygen consumption will peak or plateau
- treadmill, bike
  - increase resistance on bike or grade on treadmill

How are results incorporated into training?

- follow-up VO2 tests can be used as a measure of progress

How does training affect VO2max?

- training --> increase in efficiency of oxygen transport within the body
- lowering resting HR and HR at sub maximal loads --> heart pumps more blood each beat

Health and performance considerations

- higher aerobic fitness levels are associated with numerous health benefits (longer lifespan, better quality of life, reduced risks for stroke, heart disease, diabetes and cancer, improved mood and self-esteem, and improved sleep patterns)
- higher VO2 max --> more potential for greater performance levels in aerobic endurance event (running, biking, swimming)

Link: https://health.ucdavis.edu/sportsmedicine/resources/vo2description.html

Citation:

"VO2 Max and Oxygen Consumption." UC Davis Sports Medicine. https://health.ucdavis.edu/sportsmedicine/resources/vo2description.html (accessed September 15, 2021).

Conclusions/action items:

- look at how VO2 masks are used in research
- look at current models of VO2 masks, compare to provided model

9/15/2021 - VO2 Max Testing in Research

JAKOB KNAUSS - Sep 15, 2021, 3:22 PM CDT

Title: VO2 Max Testing in Research

Date: 09/15/2021

Content by: Jakob Knauss

Present: N/A

Goals: Understand how VO2max testing is applied in research.

Content:

Title: Effects of high intensity training and continuous endurance training on aerobic capacity and body composition in recreationally active runners

Overview

- examining effects of high-intensity-training program (AW) vs. continuous-endurance-training program (WE) on aerobic power and body composition
- aerobic power measured using exhaustive treadmill test
- improvements of VO2 peak were significantly greater in the high intensity training group compared to the continuous endurance training group
- both groups completed half marathon with no significant differences in performance
- "short, intensive endurance training sessions of about 30 min are effective in improving aerobic fitness in recreationally active runners"

VO2 testing application

- cardiovascular fitness (VO2 peak) was one of several variables assessed before and after the training program intervention was completed
- assessed using treadmill stage test and spirometry
- increase speed by 1.5 km/h every 3 min, start from 7.5 km/h until objective exhaustion
- both groups improved aerobic power, difference in peak aerobic power between groups was significant
- high-intensity training proved more effective in increasing relative peak oxygen uptake
- a training program requiring a higher oxygen delivery leads to greater adaptations of the oxygen delivery system, possibly as a result of frequent training at higher intensities

Article pdf attached below.

Link: https://www.jssm.org/jssm-11-483.xml%3EFulltext

Citation:

Kuno Hottenrott, Sebastian Ludyga, and Stephan Schulze, "Effects of high intensity training and continuous endurance training on aerobic capacity and body composition in recreationally active runners," *Journal of Sports Science and Medicine*, vol. 11, pp. 483-488, 2012.

Conclusions/action items:

- Research current VO2 mask designs and investigate the provided masks we are working with

- Review the testing procedure and study that the client sent for using the VO2 max testing

JAKOB KNAUSS - Sep 13, 2021, 4:12 PM CDT

jssm-11-483.pdf(251.8 KB) - download

10/20/2021 - Broader Impact of Problem and Solution

JAKOB KNAUSS - Oct 20, 2021, 10:40 AM CDT

Title: Broader Impact of Problem and Solution

Date: 10/20/2021

Content by: Jakob Knauss

Present: N/A

Goals: Articulate the overarching significance of this project, and how it can make a large impact

Content:

As a person that does not wear glasses, the problem that we are tasked with solving had never crossed my mind. However, this highlights the importance of exposing yourself to people with diverse backgrounds and experiences. Especially as an engineer, you need to look at a problem from multiple perspectives to be able to produce the most effective solution. This is a theme I picked up on last semester in BME 201 when we were talking about which populations were most affected by diabetic foot ulcers and how we can cater the design to the needs of those populations. This is an important idea to keep in mind for any design project. The goal is to provide a solution that is effective for as many people as possible, not just people similar to yourself.

Conclusions/action items:

- Continue to view issues from multiple perspectives to create designs and solutions that cater to as many people as possible.

10/7/2021 - Facial Measurements

JAKOB KNAUSS - Oct 07, 2021, 1:04 PM CDT

Title: Facial Measurements

Date: 10/7/2021

Content by: Jakob Knauss

Present: N/A

Goals: Find facial measurements for adult humans. We are specifically looking for measurements involving the nose, so we can apply them to whichever alteration of the nose piece our team decides to pursue.

Content:

I will have to review these resources at another time, but there were a couple key takeaways:

- These measurements varied heavily depending on a person's gender, ethnicity, and age group. These are factors that we will have to consider when choosing which measurements are applicable to the population of people who would use our mask. The idea is that our mask will accommodate any face shape, so it is the goal for our design to be inclusive of all genders, ethnicities, and age groups. This is an important diversity consideration for equal access of our product to people with different identities, backgrounds, cultures, and ages.
    - International Anthropometric Study of Facial Morphology in Various Ethnic Groups/Races + Facial Anthropometric Differences among Gender, Ethnicity, and Age Groups
- The various articles provide anthropometric measurements of the human face. I will reference these tables when our team figures out which measurements will be relevant to our design.
- The articles also provide some applications of these measurements including face shape modeling.
    - Face to Face: Anthropometry-Based Interactive Face Shape Modeling Using Model Priors

Links:

Face to Face: Anthropometry-Based Interactive Face Shape Modeling Using Model Priors

Standards of Facial Esthetics: An Anthropometric Study

Head and Face Anthropometry of Adult U.S. Civilians

Facial Anthropometric Differences among Gender, Ethnicity, and Age Groups

International Anthropometric Study of Facial Morphology in Various Ethnic Groups/Races

Citations:

Yu Zhang and Edmond C. Prakash, "Face to Face: Anthropometry-Based Interactive Face Shape Modeling Using Model Priors," *International Journal of Computer Games Technology*, vol. 2009, 15 pages, 2009.

H. Jagadish Chandra, M. S. Ravi, S. M. Sharma, and B. Rajendra Prasad, "Standards of Facial Esthetics: An Anthropometric Study," *J. Maxillofac Oral Surg*, vol. 11, no. 4, pp. 384-389, 2012.

Joseph W. Young, "Head and Face Anthropometry of Adult U.S. Civilians," U.S. Department of Transportation Aviation *Administration*, 1993.

Ziqing Zhuang, Douglas Landsittel, Stacey Benson, Raymond Roberge, and Ronald Shaffer, "Facial Anthropometric Differences among Gender, Ethnicity, and Age Groups," *Ann. Occup. Hyg.*, vol. 54, no. 4, pp. 391-402, 2010.

Leslie G. Farkas et. al, "International Anthropometric Study of Facial Morphology in Various Ethnic Groups/Races," *Journal of Craniofacial Surgery*, vol. 16, no. 4, pp. 615-646, 2005.

Conclusions/action items:

- Incorporate these measurements into our design going forward. They will be important for determining the size of the clips and if we need to lower the nose piece at all.

https://www.faa.gov/data_research/research/med_humanfacs/oamtechreports/1990s/media/am93-10.pdf

JAKOB KNAUSS - Oct 07, 2021, 11:46 AM CDT

573924.pdf(5.2 MB) - download

JAKOB KNAUSS - Oct 07, 2021, 11:47 AM CDT

12663_2012_Article_355.pdf(408.4 KB) - download

JAKOB KNAUSS - Oct 07, 2021, 10:17 AM CDT

am93-10.pdf(1.3 MB) - download

JAKOB KNAUSS - Oct 07, 2021, 11:47 AM CDT


Facial Anthropometric Differences among Gender, Ethnicity, and Age Groups

meq007.pdf(389.9 KB) - download

JAKOB KNAUSS - Oct 07, 2021, 11:46 AM CDT

InternationalAnthropometricStudyofFacialMorphologyinV....pdf(256.4 KB) - download

11/28/2021 - Key Glasses Measurements

JAKOB KNAUSS - Nov 28, 2021, 10:05 PM CST

Title: Key Glasses Measurements

Date: 11/28/2021

Content by: Jakob Knauss

Present: N/A

Goals: Identify glasses measurements that should be recorded during testing.

Content:

Key measurements:

- Lens height
- Lens width
- Frame width
- Bridge width
- Temple length
- Glasses shape (general description)

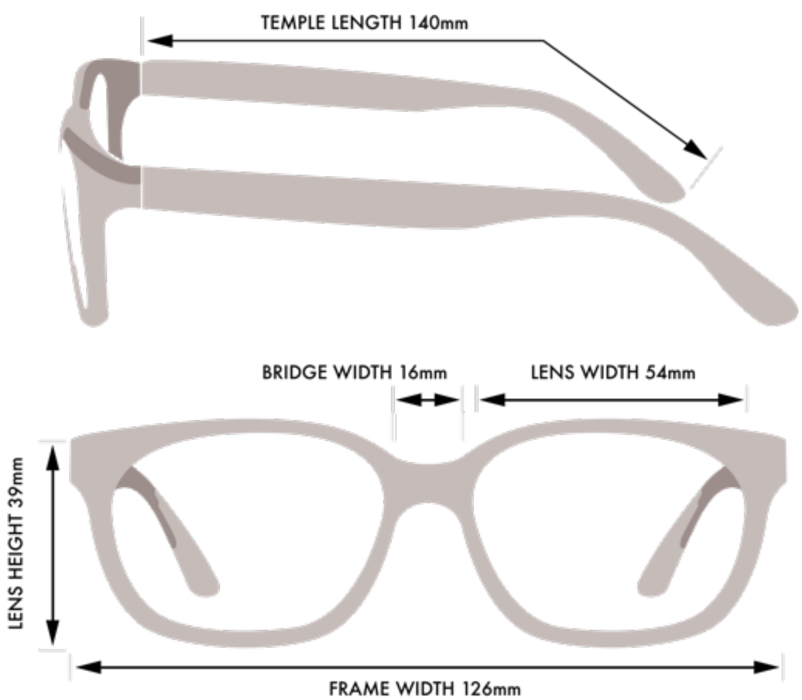


Figure 1: Key Measurements of Glasses

These measurements will be useful to record during testing, so we can identify how different glasses measurements and shapes impact the usability and comfort of our design.

Links:

https://www.glassesgallery.com/size-guide

Citations:

[1] Glasses Gallery, "Guide to Glasses Frame Size", Accessed: Nov. 28, 2021. [Online]. Available: https://www.glassesgallery.com/size-guide

Conclusions/action items:

- obtain these measurements for subject's glasses during testing to determine if any glasses are not accommodated by our design and which measurement may contribute to this

10/6/2021 - Statistical Testing to Prove Equivalency

JAKOB KNAUSS - Oct 06, 2021, 11:23 PM CDT

Title: Statistical Testing to Prove Equivalency

Date: 10/6/2021

Content by: Jakob Knauss

Present: N/A

Goals: Figure out how we can set up testing and data analysis to attempt to prove equivalency between the VO2 max testing results for our design and the existing VO2 masks.

Content:

A statistical test using paired data is ideal for our application. We want to be comparing the VO2 output measurements between the individual wearing the existing mask and the same individual wearing the new mask. We are not interested in compiling the average of multiple subjects using a certain type of mask because the results are specific to the individual subject.

We want to use an equivalence test (not a t test) to prove equivalence between the two groups. A t test proves that two groups are different, but that is not our goal. An equivalence test involves setting an accepted range of values that are "close enough" to be considered equivalent to the reference mean. This equivalence interval, also called the zone of equivalence, is based on your knowledge of the product or process and should be determined before you perform the test. The analysis then determines whether you have enough evidence to claim that the difference (or ratio) between the population means is within the equivalence interval. This interval / accepted deviation is something we can discuss with our client and perform research to determine.

The sample size has to be large enough that the findings and results can be generalized to any individual performing the VO2 max testing using this mask. This number still has to be determined based on how many subjects are necessary to provide statistically significant results and based on availability and resources.

Link: https://support.minitab.com/en-us/minitab/18/help-and-how-to/statistics/equivalence-tests/how-to/equivalence-test-with-paired-data/before-you-start/overview/

Citation:

"Overview for Equivalence Test with Paired Data." Minitab 18 Support. https://support.minitab.com/en-us/minitab/18/help-and-how-to/statistics/equivalence-tests/how-to/equivalence-test-with-paired-data/before-you-start/overview/ (accessed October 6, 2021).

Conclusions/action items:

- Discuss testing plans with team, and write up a detailed testing plan for proving equivalency. We should also figure out how we plan to assess user comfort and glasses fit.
- Locate and review notes from previous statistics course. Figure out how to run test in MATLAB.

JAKOB KNAUSS - Oct 07, 2021, 9:06 AM CDT

EDIT:

Content:

After reviewing my notes from AP statistics, it looks like we did not cover equivalence tests, but it was a good refresher on how to set up a significance test or confidence interval, what conditions need to be satisfied for each test, and what conclusions you can draw based on the results. I did find this document online describing how to use a paired t-test for equivalence. I think this is the type of test we want to conduct, but we can run it by our advisors to be sure. I also don't know if a confidence interval of some sort could be used to prove equivalence.

Link: https://ncss-wpengine.netdna-ssl.com/wp-content/themes/ncss/pdf/Procedures/PASS/Paired_T-Tests_for_Equivalence.pdf

Citation:

"Paired T-Tests for Equivalence." NCSS Statistical Software. https://ncss-wpengine.netdna-ssl.com/wp-content/themes/ncss/pdf/Procedures/PASS/Paired_T-Tests_for_Equivalence.pdf (accessed October 7, 2021).

JAKOB KNAUSS - Oct 07, 2021, 9:06 AM CDT

Paired T-Tests for Equivalence

Introduction

Outline of an Equivalence Test

Paired_T-Tests_for_Equivalence.pdf(244.4 KB) - download

JAKOB KNAUSS - Oct 07, 2021, 1:42 PM CDT

EDIT:

Content:

This article is very useful in explaining the application of equivalence testing. It even provides examples using physical activity measures such as VO2. I will share this article with the team.

Link: 10.1249/MSS.0000000000001481

Citation:

Philip M. Dixon, Pedro F. Saint-Maurice, Youngwon Kim, Paul Hibbing, Yang Bai, and Gregory J. Welk, "A Primer on the Use of Equivalence Testing for Evaluating Measurement Agreement," *Med Sci Sports Exerc.*, vol. 50, no. 4, pp. 837-845, 2019.

JAKOB KNAUSS - Oct 07, 2021, 10:17 AM CDT

HHS Public Access

A Primer on the Use of Equivalence Testing for Evaluating Measurement Agreement

nihms916849.pdf(552 KB) - download

10/18/2021 - Understanding Equivalence and Noninferiority Testing

JAKOB KNAUSS - Oct 20, 2021, 9:32 AM CDT

Title: Understanding Equivalence and Noninferiority Testing

Date: 10/18/2021

Content by: Jakob Knauss

Present: N/A

Goals: Figure out how we can set up testing and data analysis to attempt to prove equivalency between the VO2 max testing results for our design and the existing VO2 masks.

Content:

This article was provided by one of our advisors to outline how equivalence and noninferiority testing is set up and what conclusions can be drawn. This is a great resource because it goes through the significance of this form of testing as well as its unique components (compared to normal t-tests. Some important points regarding equivalence testing are highlighted below:

- Null hypotheses: The two treatments are not equivalent.
- Research hypotheses: The new treatment is equivalent to the current treatment.
- The term equivalent is not used here in the strict sense, but rather to mean that the efficacies of the two treatments are close enough so that one cannot be considered superior or inferior to the other.
    - "close enough" to be considered equivalent --> equivalence margin
    - The equivalence margin, denoted by δ, is the most distinctive feature of equivalence/noninferiority testing.
    - The determination of the equivalence margin, δ, is the most critical step in equivalence/noninferiority testing.
        - The article talks about using previous studies to establish a justified equivalency margin value. In our case, I think we would focus on the measurement error (3%) of the CardioCoach system that we would be using to run the VO2 max testing with both masks.
- simplest and most widely used approach to test equivalence = two one-sided test (TOST) procedure
    - Using TOST, equivalence is established at the α significance level if a (1–2α) × 100% confidence interval for the difference in efficacies (new – current) is contained within the interval (-δ, δ)
- no difference is not the same as equivalence
- further information is provided about data analysis

Link: https://dx.doi.org/10.1007%2Fs11606-010-1513-8

Citation:

Esteban Walker and Amy S. Nowacki, "Understanding Equivalence and Noninferiority Testing," *J Gen Intern Med.*, vol. 26, no. 2, pp. 192-196, 2010.

Conclusions/action items:

- Finalize testing plans after fabrication is underway.
- Find out how we will analyze data if only one person is allowed to perform the VO2 max testing.

JAKOB KNAUSS - Oct 20, 2021, 9:30 AM CDT


Understanding Equivalence and Noninferiority Testing

11606_2010_Article_1513.pdf(156.3 KB) - download

12/4/2021 - Statistical Analysis Method for Discrete Data

JAKOB KNAUSS - Dec 04, 2021, 10:05 PM CST

Title: Statistical Analysis Method for Discrete Data

Date: 12/4/2021

Content by: Jakob Knauss

Present: N/A

Goals: Find correct statistical analysis to perform on data to be collected in testing (discrete data).

Content:

- General Comments
  - a larger sample size is necessary to make effective conclusions from data
  - random sample would be ideal to eliminate bias
  - data being collected: numerical data, discrete data (not continuous)
    - discrete data --> data can't be assumed to follow a normal distribution
    - small sample size --> t-test is not robust against violations of this normality assumption
  - analysis options encountered
    - ANOVA, t-tests, correlation analyses, chi-squared test, Wilcoxon signed-rank test*
- Wilcoxon Signed Rank Test
  - does not assume normal distribution (non-parametric test)
  - computes the difference between each set of matched pairs, then follows the same procedure as the signed rank test to compare the sample against some median (paired data*)
  - null hypothesis: medians of two samples are equal, no difference in medians
  - alternative hypothesis: medians are different (two-tailed), median1 > median2 (one-tailed)
  - non-parametric alternative to the one-sample t-test or paired t-test
    - paired t-test assumption: difference between variables represents normal distribution
  - for ordered (ranked) categorical variables without a numerical scale
  - possible issues when variable for set 1 and set 2 have same value (difference = 0), some kind of workaround
  - good summary of the test
    - https://www.statisticshowto.com/wilcoxon-signed-rank-test/
  - use MATLAB
    - https://www.mathworks.com/help/stats/signrank.html
- Performing the Test
  - Null Hypothesis: M1 = M2; Alternative Hypothesis: M1 < M2 (or M1 > M2 depending on question) --> one-tailed test bc we are looking for improvement compared to existing design; alpha = 0.05
  - Survey results for specific question w/ existing mask and w/ new mask for each subject
  - Calculate difference between rating w/ existing mask and w/ new mask for each subject
  - Calculate absolute difference for each subject (absolute value of previous number)
  - Rank absolute values from smallest to largest value (rank 1, 2, 3, ...)
  - T- = sum of ranks for negative differences
  - T+ = sum of ranks for positive differences
  - W = test statistic = lesser number of T- and T+
  - Critical Values of the Wilcoxon Signed Ranks Test Table

        - Two-Sided Test vs. One-Tailed Test
        - n (sample size)
        - alpha (significance level)
        - for our testing, one-sided test, n = 5, alpha = 0.05 --> Wcrit (critical value) = 0
        - this means we will not be able to draw conclusions from the testing we perform because our sample size is too small
    - Wstat < Wcrit --> reject null hypothesis
    - *Wstat > Wcrit --> fail to reject null hypothesis (provide reasoning here, due small sample size)
    - https://www.youtube.com/watch?v=TqCg2tb4wJ0&ab_channel=EugeneO%27Loughlin

n	Two-Tailed Test		One-Tailed Test	
	$\alpha = .05$	$\alpha = .01$	$\alpha = .05$	$\alpha = .01$
5	--	--	0	--
6	0	--	2	--
7	2	--	3	0
8	3	0	5	1
9	5	1	8	3
10	8	3	10	5
11	10	5	13	7
12	13	7	17	9
13	17	9	21	12
14	21	12	25	15
15	25	15	30	19
16	29	19	35	23
17	34	23	41	27
18	40	27	47	32
19	46	32	53	37
20	52	37	60	43
21	58	42	67	49
22	65	48	75	55
23	73	54	83	62
24	81	61	91	69
25	89	68	100	76
26	98	75	110	84
27	107	83	119	92
28	116	91	130	101
29	126	100	140	110
30	137	109	151	120

- In addition to statistical tests, we can make general observations about trends in the data
    - before, during, and after activity
    - use during activity ratings for statistical analysis

Link:

Citation:

Conclusions/action items:

- Perform testing and collect results.
- Perform statistical analysis and explain how testing and analysis could be performed differently to achieve more relevant results.

JAKOB KNAUSS - Dec 13, 2021, 12:46 PM CST

EDIT:

Content:

Summary of the Wilcoxon Signed Rank Test and Sign Test:

Wilcoxon Signed Rank Test Description: The null hypothesis says that the median of group one is equal to the median of group two. The alternative hypothesis says that the two medians are different. Absolute differences are ranked from least to greatest in ascending order. The rank awarded to tied differences is the average of the ranks associated with those numbers. For example, if there are three differences of 1 tied for rank 1, the rank awarded to each would be the average of 1, 2, and 3 → 2. T+ is the sum of the ranks for values with positive differences, and T- is the sum of the ranks for values with negative differences. The lesser of these two numbers is used as the test statistic. The critical value/statistic is given in a table based on the significance level and sample size. The test statistic is then compared to the critical value. If the test statistic is less than the critical value, then there is a significant difference between the two medians (reject the null hypothesis).
https://www.statisticshowto.com/wilcoxon-signed-rank-test/

Sign Test Description: This test is very similar to the Wilcoxon Signed Rank Test. The null hypothesis and alternative hypothesis are the same. No ranks are assigned, and results are based solely on whether each calculated difference is positive or negative. Find the p-value from a binomial distribution table and compare it to the significance level to determine whether to reject or fail to reject the null hypothesis.
https://www.statisticshowto.com/sign-test/

Links:

https://www.statisticshowto.com/wilcoxon-signed-rank-test/

https://www.statisticshowto.com/sign-test/

Citations:

[1] S. Glen, "Wilcoxon Signed Rank Test: Definition, How to Run, SPSS," *Statistics How To*, Sep. 17, 2021. https://www.statisticshowto.com/wilcoxon-signed-rank-test/ (accessed Dec. 04, 2021).
[2] S. Glen, "Sign Test: Step by Step Calculation," *Statistics How To*, Mar. 1, 2016. https://www.statisticshowto.com/sign-test/ (accessed Dec. 04, 2021).

9/15/2021 - Commercially Available VO2 Mask Designs

JAKOB KNAUSS - Sep 15, 2021, 4:37 PM CDT

Title: Commercially Available VO2 Mask Designs

Date: 09/15/2021

Content by: Jakob Knauss

Present: N/A

Goals: Explore some of the mask designs that are currently available for use**.**

Content (CardioCoach):

Figure 1: Subject demonstrating the use of the CardioCoach VO2 max testing.

- delivers simple and accurate fitness testing based on oxygen consumption
- utilizes mixing chamber
- calibrates for barometric pressure, temperature, and humidity
- uses anaerobic threshold and VO2 max results to define unique workout zones
- simple to use, affordable

Figure 2: CardioCoach VO2 Mask Reusable Face Plate.

- Hans Rudolph Reusable mask for VO2 testing
- highest quality construction for outstanding fit and accurate testing
- multiple sizes available
- this is the piece that our team is tasked with designing
- our design must allow the user to wear glasses, so it can't have the thick nose piece
- our design must function with the rest of the system that the client is currently using (account for tubing sizes, etc.)

Links:

https://korr.com/products/vo2-max-testing-system/

https://korr.com/product/vvo2-mask-reusable-face-plate-2/

Citations:

"CardioCoach VO2 Max Testing Equipment." Korr Medical Technologies Inc.. https://korr.com/products/vo2-max-testing-system/ (accessed September 15, 2021).

"VO2 Max Reusable Face Mask." Korr Medical Technologies Inc.. https://korr.com/product/vvo2-mask-reusable-face-plate-2/ (accessed September 15, 2021).

Content (VO2 Master Analyzer):

Figure 3: VO2 Master Analyzer design.

- performance testing (VO2 max+ zones)
- no backpacks, cables, or hoses
- similar to the CardioCoach design above, except sensor is attached to mask (instead of being connected by tube)

Figure 4: VO2 Master Analyzer Face Mask.

- the face mask looks very similar to the one used in the CardioCoach system
- it also has a wide nose piece, so the user could not wear glasses

Links:

https://vo2master.com/analyzer/

https://vo2master.com/product/face-mask/

Citations:

"VO2 Master Analyzer." VO2 Master. https://vo2master.com/analyzer/ (accessed September 15, 2021).

"Face Mask | VO2 Master." VO2 Master. https://vo2master.com/product/face-mask/ (accessed September 15, 2021).

Conclusions/action items:

- compare these products to the masks that our client supplies us with

- brainstorm and sketch design ideas allowing the user to wear glasses

JAKOB KNAUSS - Sep 15, 2021, 3:56 PM CDT

VO2-Max-Brochure-v2019_8.0.pdf(1006.4 KB) - download

9/20/2021 - Johnson Health Tech VO2 Instructional Document

JAKOB KNAUSS - Sep 20, 2021, 4:17 PM CDT

Title: Johnson Health Tech VO2 Instructional Document

Date: 09/20/2021

Content by: Jakob Knauss

Present: N/A

Goals: Understand the procedure for how the VO2 mask is used by our client.

Content:

*KORR Medical Technologies protocol or equipment (CardioCoach)

VO2 Collection Prep

- plug in two cords
- participants chooses small or medium face mask and harness (based on which mask prevents air leakage without being too tight)
- participant puts heart rate monitor strap around chest, plug in HR jack, HR readout should appear on front of VO2 unit
- ventilation hose attaches to front of VO2 unit at Air Intake port, hose attaches to Y-connector on other end
  - 5 parts of the Y-connector: 2 unique adaptors, 2 identical one-way valves, and Y-shape itself
  - construct Y-connector and attach to face mask and ventilation hose
- clip harness onto facemask, make sure participant is comfortable and understands the remainder of the test

VO2 Collection

- open Cardio Coach software, New Test button, Test Type = Treadmill Test, do not change Equipment
  - choose or create new participant for tracking purposes
- auto-calibration: accounts for temperature, humidity, and oxygen content of ambient air
- after calibration, the hose should be connected and the first breath will be sensed
- an additional 90 second calibration period will take place ensuring HR and VO2 signals are being picked up and stable
- ready for testing! (device can run for about 25 minutes before needing to be re-calibrated)

VO2 User Interface

- Displayed Graphs and Measaurements
  - VO2 vs. time AND HR vs. time (main indicated of a "successful" test, peaks in VO2 and HR should correlated with periods of increased exercise/intensity)
  - Ve/VO2 vs. time AND HR vs. time
  - VO2/HR vs. time AND HR vs. time
  - Ve vs. VO2
  - HR vs. VO2
  - Ve vs. time
- VO2 (mL/kg body weight/min) = volume of O2 consumed per minute, relative to participant body weight
- Ve (liters/min) = volume of air expired per minute

VO2 Analysis

- export file contains: time, HR, VO2 (mL/kg/min), VO2 (mL/min), Ve/VO2, Ve, FeO2 (fraction of oxygen in expired air)
- if participant info (height, weight, etc.) was not entered initially, VO2 will have to be re-calculated in Excel for example

VO2 Cleanup

- thoroughly clean facemask, ventilation hose, and all parts of the Y-connector with soap and water
- allow adequate time for cleaning and drying in between participants
- use an alcohol pad to cleanse HR strap and monitor

Citation:

Korr Medical Technologies, "VO2 Instructional Document," Apr. 23, 2019. [Accessed: Sep. 20, 2021].

Conclusions/action items:

- Use this information to provide accurate description for Safety, Accuracy and Reliability, and Life in Service sections of the PDS.

JAKOB KNAUSS - Sep 20, 2021, 4:03 PM CDT

VO2_Instructional_Document.docx(1 MB) - download

9/20/2021 - Johnson Health Tech Step+ VO2 Validation

JAKOB KNAUSS - Sep 20, 2021, 4:47 PM CDT

Title: Johnson Health Tech Step+ VO2 Validation

Date: 09/20/2021

Content by: Jakob Knauss

Present: N/A

Goals: Review a validation study from the client involving VO2 max testing.

Content:

Purpose and Goal

- validate the utility of ACSM's published equation for estimating VO2 by comparing calculated to measured VO2 values
- by verifying both ACSM's published equation and the Step+ as reliable for measuring submaximal VO2, the Step+ can be marketed as a quick and easy assessment tool for estimating cardiorespiratory fitness

Protocol

- set up Step+ and VO2 mask equipment
- first step test for 3 minutes at a step rate of 20 bpm
    - if subject's HR does not equal or exceed 85% of age-predicted max HR (220 - age in years) during testing, subject will sit for 4 minutes before second step test
- second step test for 3 minutes at 25 bpm
    - if subject's HR does not equal or exceed 85% of age-predicted max HR during testing, subject will sit for 6 minutes before third step test
- third step test for 3 minutes at 30 bpm
- testing complete, remove HR monitor and mask
- data from each step test will be isolated, HR and VO2 data will be averaged across final minute
- 20 bpm trials, 25 bpm trials, and 30 bpm trials from each subject will be grouped, and statistical significance tests (alpha = 0.05) will be conducted for each group to determine if differences in calculated vs. measured VO2 exist (sample size >= 10)

Results

Taking the average from the last minute of each test, the VO_2 value for each step rate test is seen below in Table 1.

Average VO_2 mL/(kg*min)		
20 bpm	25 bpm	30 bpm
18.2	26.3	34.2

Table 1. VO_2 value measured by averaging last minute of each step rate test

Using Equation 1 from ACSM, calculations for VO_2 values were made for step rates of 20, 25, and 30 bpm, as seen in Table 2.

Equation 1. $VO_2\left(\frac{mL}{kg*min}\right) = (0.2 * f) + (1.33 * 1.8 * H * f) + 3.5\ \frac{mL}{kg*min},$

where H = height of Step+ in meters, and f = frequency of stepping in beats per minute

Height \ Step Rate	20 beats/min	25 beats/min	30 beats/min
0.32766 m (= 12.9 in)	23.19	28.11	33.03

Table 2. Calculated values for VO_2, according to published ACSM equation.

Citation:

J. Muench, "Step+ VO2 Validation," no. 2, Jul. 17, 2018. [Accessed: Sep. 20, 2021].

Conclusions/action items:

- Use this information to provide accurate description for Safety, Accuracy and Reliability, and Life in Service sections of the PDS.

JAKOB KNAUSS - Sep 20, 2021, 4:46 PM CDT

Step__Protocol.docx(88.2 KB) - download

11/05/2021 - Hans Rudolph Mask Specifications

JAKOB KNAUSS - Nov 28, 2021, 9:32 PM CST

Title: Hans Rudolph Mask Specifications

Date: 11/05/2021

Content by: Jakob Knauss

Present: N/A

Goals: Find key measurements and specifications for the existing masks provided by Johnson Health Tech.

Content:

Key specifications/measurements:

- Face Piece Material: Silicone Rubber Blue
- Structural Braces Material: Polycarbonate Thermoplastic
- Headgear Material: Polyurethane Foam Black, Nylon UBL Gray and Nylon Fabric Red
- Headgear Hook Material: Nylon, Black
- Headgear Strap Clips (4), Tri-glide: Polypropylene, Black
- Mask and Headgear Service Life: expected to stay in service for minimum of 25 disinfection or sterilization cycles or 6 months of use under normal conditions, headgear is expected to stay in service for 6 months of use
- Operational Conditions for Use: 5-40 C temperature range, 0-95% RH humidity range
- The small and medium mask face piece sizes are relevant for our project because these are the two sizes that the client currently uses

Characteristic	Mask face Piece Sizes				
	Large (L)	Medium (M)	Small (S)	Extra Small (ES)	Petite (P)
A (inches)	5.9	5.6	5.2	4.8	4.6
B (inches)	3.7	3.4	3.2	3.1	3.0
C (inches)	4.2	4.2	4.0	3.9	3.9
Deadspace (ml)	143	125	99	88	78
Weight (gm)	128	118	100	89	83

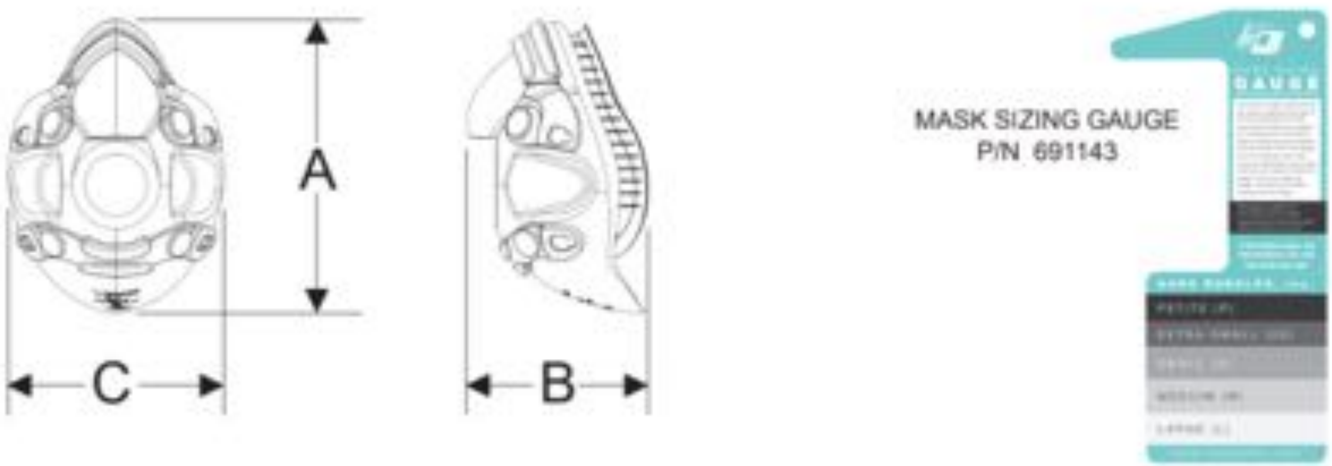


Figure 1: Key Measurements for Hans Rudolph Mask

This seems to be the standard VO2 max testing mask that is used as it is used with several of the testing systems research earlier this semester. This includes the CardioCoach system and the VO2 Master Analyzer.

Links:

https://www.rudolphkc.com/product-page/7450-series-silicone-v2-oro-nasal-mask

https://drive.google.com/file/d/1q00KffuiRB-xg-5oAwKshpidCOXG2XM2/view

https://drive.google.com/file/d/1A-Md6J4gb61QJcW6Nq9UIu4KuwmSc5UZ/view

Citations:

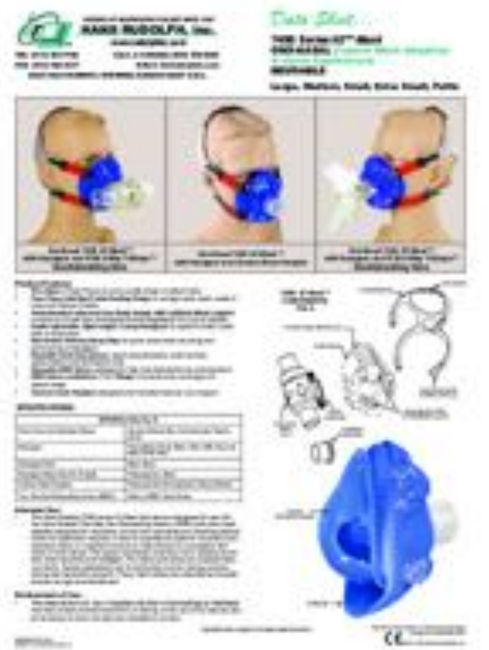
[1] Hans Rudolph, inc., “7450 Series Silicone V2^{TM} Oro-Nasal Mask Maintenance.” Hans Rudolph, inc. Accessed: Nov. 05, 2021. [Online]. Available: https://drive.google.com/file/d/1A-Md6J4gb61QJcW6Nq9UIu4KuwmSc5UZ/view

[2] Hans Rudolph, inc., “7450 Series Silicone V2^{TM} Oro-Nasal Mask Data Sheet.” Hans Rudolph, inc. Accessed: Nov. 05, 2021. [Online]. Available: https://drive.google.com/file/d/1q00KffuiRB-xg-5oAwKshpidCOXG2XM2/view

Conclusions/action items:

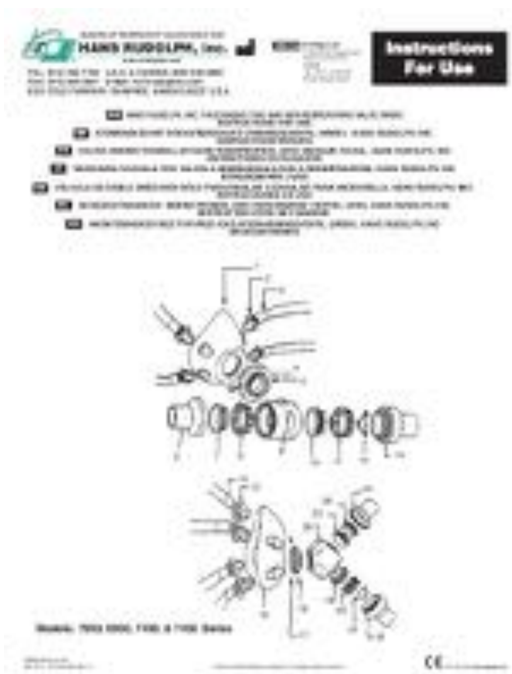
- use these measurements and specifications to help determine measurements and materials for compatible extension piece

JAKOB KNAUSS - Nov 28, 2021, 8:50 PM CST



691267.pdf(1.4 MB) - download Data Sheet

JAKOB KNAUSS - Nov 28, 2021, 8:51 PM CST



691195.pdf(286.6 KB) - download Maintenance

9/29/2021 - Design Brainstorm

JAKOB KNAUSS - Sep 29, 2021, 4:22 PM CDT

Title: Design Brainstorm

Date: 09/29/2021

Content by: Jakob Knauss

Present: N/A

Goals: Come up with possible design ideas to share with the team as we decide on three design alternatives to assess using a design matrix.

Content:

Design 1: Clamps

- two small adjustable clamps on each side (left/right) of mask to hold glasses in place
- slits/indentations for glasses to slot into
- adjust clamps using a crank or manually
- need to be adjustable for glasses of different sizes and thickness
- this design will provide better fit of the glasses on the user's face

Design 2: Barrier

- barrier on ledge to hold glasses in place located anterior to the glasses holding glasses so they don't slide down nose
- one-size-fits-all, but might not restrict movement of glasses as well as clamps
- this design is easier to use

*A picture of my crude sketches of these designs is attached below.

Conclusions/action items:

- Share these ideas with the team at our meeting today (9/28).
- Weigh these designs against alternatives using a design matrix, which is due Friday 10/1.
- Make better drawings!

JAKOB KNAUSS - Sep 29, 2021, 4:24 PM CDT

Design_Brainstorm_Initial_Drawings.jpg(542.9 KB) - download

10/14/2021 - Final Proposed Design

JAKOB KNAUSS - Oct 20, 2021, 10:23 AM CDT

Title: Final Proposed Design

Date: 10/14/2021

Content by: Jakob

Present: Entire team

Goals: Establish a final proposed design to move forward with into fabrication and testing

Content:

Sinan's sketch of the final proposed design (three-clamp design)

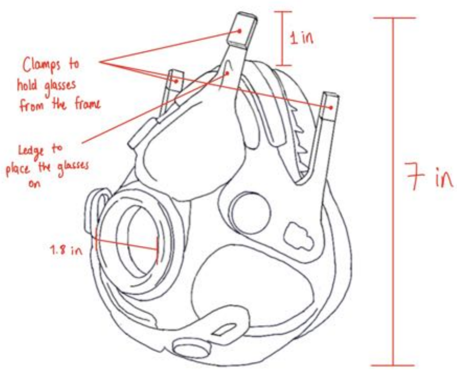


Figure 1: Sketch of final proposed design

Conclusions/action items:

- Build off of this design as the team moves forward into the fabrication phase of our project
- Make necessary adjustments as we figure out what works and what doesn't for securing the glasses with the mask

10/23/2021 - Glasses Clips Design Brainstorm

JAKOB KNAUSS - Oct 23, 2021, 10:43 PM CDT

Title: Glasses Clips Design Brainstorm

Date: 10/23/2021

Content by: Jakob

Present: N/A

Goals: Brainstorm design alternatives for glasses clip attachments to mask

Content:

Figure 1: Existing mask product (VO2 Mask Reusable Face Plate)

- During our team meeting on Friday, the team came up with a new approach to our mask design:
    - Instead of 3D printing or molding a completely new mask, we plan to design and 3D print a new plastic attachment piece for the existing masks. The two plastic attachment pieces are visible in Figure 1, and both pieces are easy to remove and reattach to the mask. The bottom piece can remain the same, but we plan to reprint the top one to include the clips on each side to hold the glasses in place as well as an extension connecting the plastic piece and the clips. Also, there will need to be some kind of attachment or clip in the middle to hold the bridge of the glasses.
    - Altering this plastic accessory to the mask is a much more effective solution to our problem because if we were to 3D print or mold a new mask, we would surely introduced more error in measurements and variation to the existing design than is intended/necessary. Our advisor also brought up that 3D printing our mask would almost certainly lead to air leakage issues simply due to the nature of 3D printing (it is not a complete, continuous layer of material). The only change our client wants is for the mask to accommodate glasses, so that is the only change that needs to be made. Changing the mask itself would surely impact important factors (that are intended to remain constant with the existing masks) such as VO2 max test readings, fit to the user's face, material properties and flexibility of the mask, and measurements/size of the mask. Using the existing masks helps alleviate any deviation in these areas.
    - Some ideas to bring up with the team:

- If we are only changing this external piece of the mask, is equivalence testing really necessary? I think it is still the best way to demonstrate consistency in test readings, but changing an external piece of the mask really should not alter results.
- An important consideration is how we will make this clip/attachment piece adjustable and accommodating of user's with different types of glasses and different face shapes.
- This newly printed plastic piece must still be compatible with strap attachments and must be easy to insert and detach from the mask as it is currently.

Figure 2: (2a) Various eyeglass retainer styles (2b) How the retainers and hooks work (2c) Product measurements

- Clip Design One: Ear Grips (Clamp Behind Ear)
  - Links:
    - HKIDEE Eyeglass Ear Grip, Anti - Slip Comfortable Silicone Elastic Eyeglasses Retainers For Sunglasses Reading Glasses Eyewear, Sport Eyeglass Strap, 12 Pairs
    - Glasses Anti-slip Silicone Ear Clip, Glasses Holder, Safety Eyewear Retainers for Sunglasses Presbyopia Glasses Sports Glasses, 14 Pairs (7 Pairs of Black, 7 Pairs of Transparent)
    - 24PCS Mcyye Eyeglasses Ear Grips, Anti Slip Eyeglass Retainer, Premium Silicone Ear Hook, Keep glasses from Slipping Down Your Nose, Simple, Effective Helper for Kids, Adults, Sports, Study & Work (Figure 2)
    - and many more similar products
  - Pros:
    - many commercially available products like this

        - inexpensive
        - fit most glasses sizes
        - easy attachment and removal (shown in Figure 2b)
    - Cons:
        - further from the front of the mask = longer attachment from mask to clips
    - Notes:
        - just have to make sure design is durable and strong enough to withstand high intensity activity
        - the ear hook design is preferable to the circles because it is more convenient to connect the downward extension of the hook to the front of the mask
            - however, the ear hook can only be placed behind the ear at the end of the legs
            - the circle could be placed further up the leg, so it is easier to connect with the front of the mask
        - attachment between hook and mask could be same plastic material that the mask insert piece is constructed out of, just an extension that runs out along side of face and attaches to hook
            - maybe the attachment from the mask to these outside clips would not be necessary for these hooks because I can see potential difficulties with the ear being in the way and with different face shapes causing issues
            - the hooks themselves should hopefully provide enough support to hold glasses in place, especially if there is a center piece on the mask to support the bridge as well

Figure 3: Glasses rope/strap/band behind head product

- Clip Design Two: Strap/Band Behind Head
    - Links:
        - NUZYZ Sport Elastic Eyeglasses Anti-slip Fixing Cord Rope String Glasses Holder Strap
        - other similar products
    - Pros:
        - many commercially available products
        - relatively inexpensive
        - easily adjustable for different glasses and faces
        - sport elastic material

- Cons:
  - still need separate piece/holder on front of mask for bridge
  - this glasses band would have to go over the strap attachments holding the mask
- Notes:
  - still need some structure to secure front of glasses (or place for them to sit on front of mask)

Figure 4: Alligator clips for eyewear

- Clip Design Three: Alligator Clip
  - Links:
    - [Silver Eyeglass Smooth Alligator Clip Grips 20x10mm 2 pr 4 pcs]
  - Pros:
    - secure grip on glasses
    - accessible material
  - Cons:
    - could potentially cause damage to glasses - need some protective layer (supposedly, these specific clips have this protective layer)
    - might not be as adjustable for different glasses shapes and sizes
    - more difficult to attach/remove from glasses (usability)
  - Notes:
    - this could be used for the center piece (holding bridge of glasses) in combination with either of the first two design ideas for securing the legs of the glasses
    - if alligator clips were used to grip the sides of the glasses, an attachment between mask and clamps would also have to be designed

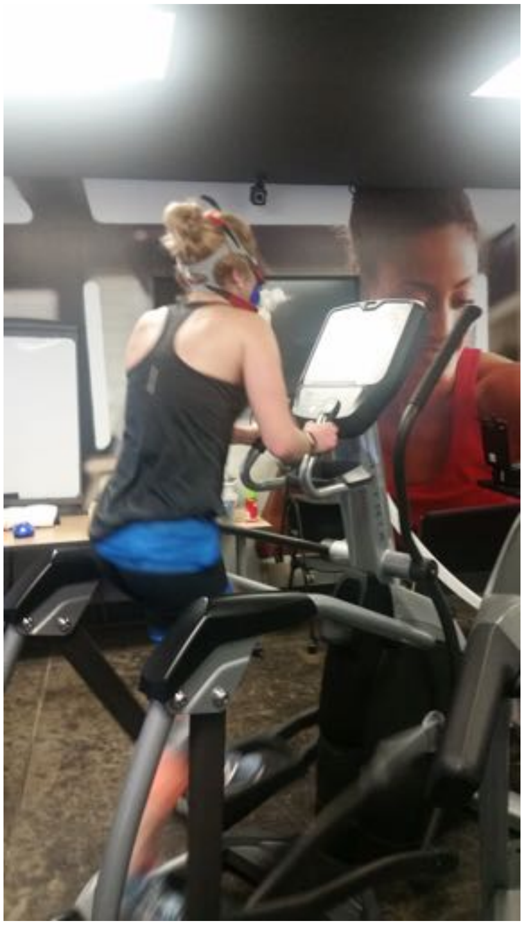


Figure 5: Subject using the existing VO2 masks with straps visible

- One potential concern that we have not thought about is whether the straps holding the mask to the user's face will impair the fit of the legs of the glasses on the sides of the person's face. The straps are visible in Figure # above.
  - I don't think this will be a concern because our client has not brought this up, but it is important to discuss with the team
  - I assume that the straps are thin enough that it would not impact the glasses fit. We do have the straps, so we can see how thick they are and which locations on the straps could cause issues.

Conclusions/action items:

- Bring these design alternatives and thoughts to team meeting this week.
- Make some rough design sketches.
- Create design matrix and decide which design idea we want to move forward with and how we will proceed.

11/28/2021 - Final Prototype Design Development

JAKOB KNAUSS - Nov 29, 2021, 5:56 PM CST

Title: Final Prototype Design Development

Date: 11/28/2021

Content by: Jakob

Present: N/A

Goals: Highlight the design development and changes the team has made since our initial proposed design

Content:

Since our initial proposed design, the team has made some changes to our design and approach. Instead of creating an entirely new mask, we decided to pursue an extension piece off of the existing mask. This decision was made because we do not have the time or resources to fabricate a new mask during this semester. It would also be unlikely that the functionality of our new mask would match that of the existing mask. While we explored the statistical analysis and testing that we could perform to prove equivalence between the two mask designs, we would not be able to test more than one subject given the fact that the VO2 max testing would have to be conducted at Johnson Health Tech's Biomechanics Lab.

For the extension piece, we decided to have the extension coming off of the plastic brace piece on the upper portion of the mask. This makes a lot of sense because the piece is external to the mask, so it should not alter the VO2 max testing output of the user. We settled on extension pieces that would extend from the brace and run along the sides of the user's head. A thin Velcro strip would then be wrapped through a small hole at the end of the extension piece and run vertically up and around the legs of the user's glasses. The Velcro is strapped to secure the glasses on the user's face, so they don't move during intense activity such as biking and running. After running into issues with being able to modify the 3d scan files of the brace piece, the team decided to print the extension piece and brace piece separately and connect them via a clip connection similar to the headgear straps connections. This does involve drilling a hole in the printed brace piece.

Conclusions/action items:

- carry out fabrication and testing
- prepare final deliverables and poster presentation
- finish the semester strong!

12/2/2021 - Final Prototype

JAKOB KNAUSS - Dec 13, 2021, 12:37 PM CST

Title: Final Prototype

Date: 12/2/2021

Content by: Jakob

Present: N/A

Goals: Show the final physical prototype that we will use for testing

Content:

The final prototype consists of three major components: the brace piece, the extension pieces, and the Velcro. As shown below, the brace piece geometry (3d printed with resin) is identical to that of the original plastic brace piece from the existing masks. A hole was drilled on each side of the mask above the hole designed for the strap clip attachments. The extension pieces use a similar mechanism to clip into these holes and run up toward the side of the user's glasses. The Velcro is then looped through the thin gap at the end of each extension piece and around the leg of the user's glasses. The Velcro and extension piece allow the design to accommodate different types of glasses as well as different face sizes.

Conclusions/action items:

- Perform functional testing according to testing protocol

JAKOB KNAUSS - Dec 13, 2021, 12:39 PM CST

3DC4C5E7-71A5-4E4A-BFCB-3EE569E114C6.jpg(326.1 KB) - download

12/9/2021 - Poster Printing

JAKOB KNAUSS - Dec 09, 2021, 12:32 PM CST

Title: Poster Printing

Date: 12/9/2021

Content by: Jakob Knauss

Present: N/A

Goals: Print poster for poster presentations

Content:

Order details are attached

- Product Name: College Library Poster Print
- Pickup Location: College Library
- Product Information:
    - Width (in inches): 48
    - Height (in inches): 36
    - Quantity: 1
    - Paper Type: satin
- Est. Cost: $48.00

Conclusions/action items:

- Poster presentations tomorrow (Friday 12/10)!

JAKOB KNAUSS - Dec 09, 2021, 12:28 PM CST


Order Details

Poster_Printing.pdf(70.2 KB) - download Order Details

10/6/2021 - 3D Scanner Resources

JAKOB KNAUSS - Oct 06, 2021, 10:54 PM CDT

Title: 3D Scanner Resources at the Makerspace

Date: 10/6/2021

Content by: Jakob Knauss

Present: N/A

Goals: Research options for 3D scanning the existing masks to generate a CAD model. Figure out if we can alter the scanned mask in SolidWorks to create our designs.

Content:

The equipment they have at the Makerspace is listed below:

- Creaform Handyscan 700: Hand-held 3D Scanner with Turntable
  - https://www.creaform3d.com/sites/default/files/assets/brochures/files/handyscan3d_brochure_en_hq_21032017_2.pdf
- Einscan: Hand-held 3D Scanner with Turntable
  - https://www.einscan.com/einscan-quick-start-guide
  - https://www.einscan.com/einscan-se-sp
- Scanse Sweep: Lidar sensor
  - https://s3.amazonaws.com/scanse/Sweep_user_manual.pdf
- Structure: iPad and mount
  - https://structure.io/getstarted
  - https://structure.io/developers

There is a dedicated room for 3D scanning: Photo Lab 217. The 3D scanner managers are Courtney Lynch, Christian Martinez, and Gaby Setyawan. We should go to the Makerspace when one of them is working.

Last year, my team utilized 3D scanning through the Makerspace, but the generated scan in SolidWorks had some holes and was very hard to use in SolidWorks. I think the masks we are using this year are a more scan-friendly shape (compared to a dog skull). It is important that we are able to use this scan to generate accurate models on SolidWorks for our design alternatives, so we are able to make accurate measurements and 3D print our new design.

Link: https://making.engr.wisc.edu/3d-scanners-2/

Citation:

"3D Scanners." UW Makerspace. https://making.engr.wisc.edu/3d-scanners-2/ (accessed October 6, 2021).

Conclusions/action items:

- Go to the Makerspace to ask which 3D scanner option will best suit our needs.
- Get the 3D scan and generate CAD models for our design alternatives.

JAKOB KNAUSS - Oct 20, 2021, 10:08 AM CDT

EDIT:

Content:

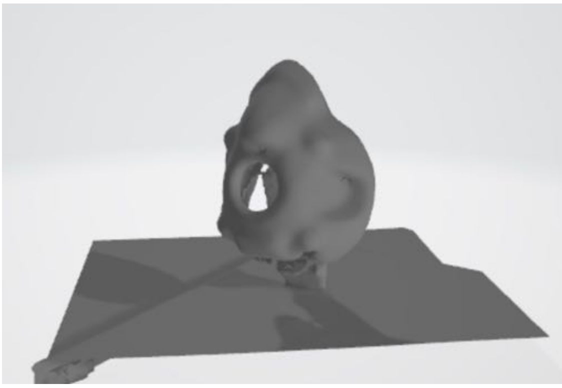


Figure 1: 3D scan of larger-sized existing mask

This is the result of the 3D scan that was performed by the Makerspace staff with Rachel and Sinan.

10/14/2021 - Makerspace 3D Printing

JAKOB KNAUSS - Oct 20, 2021, 9:54 AM CDT

Title: Makerspace 3D Printing

Date: 10/14/2021

Content by: Jakob Knauss

Present: N/A

Goals: Understand 3D printing options, process, and materials available at the Makerspace.

Content:

- 3D printers
  - Ultimaker (FFF)
  - Formlabs Form 2 and 3s (SLA)
  - Formlabs Fuse 1 (SLS)
  - Stratasys F370 (FFF)
  - Markforged & Dolomite
    - ultimaker or formlabs seem like good options
- Materials
  - all materials are relatively inexpensive
  - wide range of materials available
  - looking for something flexible, elastic, and durable
  - perhaps different materials for the two or three different materials on the existing masks
    - The existing masks consist of a main silicone piece, a deformable inner layer that comes in contact with the user's face, and plastic pieces which attach to the straps that secure the mask to the user's face.
  - further research, discussion with team, and consultation with makerspace staff will be useful
  - we can do some experimentation to see which materials will be most similar to the existing mask materials

Link: https://making.engr.wisc.edu/3d-printers-2/

Citation:

"3D Printers," *UW Makerspace*. https://making.engr.wisc.edu/3d-printers-2/ (accessed Oct. 14, 2021).

Conclusions/action items:

- Further research materials that would match material properties of existing masks
- Ask Makerspace staff what they recommend

EDIT:

Content:

Engineering Principles

It is important that we continue to develop our design and make adjustments as necessary through the fabrication process because the design process is not linear. There are always improvements and adjustments that can be made to improve the final design.

11/07/2021 - Plastic Brace Measurements

JAKOB KNAUSS - Dec 13, 2021, 12:14 PM CST

Title: Plastic Brace Measurements

Date: 11/07/2021

Content by: Jakob Knauss

Present: N/A

Goals: Obtain physical measurements of plastic brace for 3d modeling of the extension piece.

Content:

I took these measurements, so other members of the team could attempt to create 3d models of the piece. I took additional measurements of the clip mechanism involved with the straps the next day because we changed our design plan to simply modeling two extension pieces that could clip into the recreated resin brace piece.

Conclusions/action items:

- use measurements for 3d modeling of extension piece

JAKOB KNAUSS - Dec 13, 2021, 12:15 PM CST

423B0725-73A4-4BD7-BAD5-D4ECA37885F3.jpg(484.3 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:15 PM CST

,

3960EC9E-405D-4AEE-A359-C7C77B7A4A05.jpg(541.2 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:15 PM CST

,

DD9D82FB-5276-4270-BBF8-A7D0C6ED4CA0.jpg(496.7 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:16 PM CST

,

F3FAED2A-0ABE-4D81-BE2B-D745B42A3B0F.jpg(516.4 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:16 PM CST

,

F3EC89E2-62FE-4E41-9799-95C32A9739BB.jpg(594.9 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:16 PM CST

B4EFA336-51B9-433A-A059-EF63FC653847.jpg(445.5 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:17 PM CST

EAF23E18-4FCD-4A8A-8C3F-64888946E1F3.jpg(454.8 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:17 PM CST

861D684C-37FC-4D92-A123-8E6B6885F8AE.jpg(495.5 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:17 PM CST

659ADC11-89AA-4F9F-9FE5-9A6DB3495DCD.jpg(548.2 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:18 PM CST

50E0DBC6-61CF-4CBD-8045-54E2342AC8C0.jpg(570.3 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:18 PM CST

783EF0D5-02D8-42F9-BCAE-4C94C92FFF69.jpg(506.8 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:18 PM CST

97600631-0F6C-41E5-99CA-B287222CD42B.jpg(801.8 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:18 PM CST

E65C6D99-7C25-45E8-BB87-F31E808F7C69.jpg(689.6 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:19 PM CST

27952314-9A30-47BD-A7DA-F67EDE2EB5DA.jpg(851.1 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:19 PM CST

B3DA2A47-3AF0-4372-8621-D4B6155D7BEE.jpg(389.9 KB) - download

11/08/2021 - 3D Scanning at the Makerspace

JAKOB KNAUSS - Dec 13, 20

Title: 3D Scanning at the Makerspace

Date: 11/08/2021

Content by: Jakob Knauss

Present: Adrienne

Goals: Obtain a 3D scan of the plastic brace pieces for the existing masks.

Content:

11/02 -- I went into the Makerspace to 3D scan, but the scanners were undergoing maintenance. I was told to return when the 3D scanner manager, Chris scheduled to work.

11/03 -- I talked with Christian about the project and goal of 3D scanning. We set up a time for him to show me how to use the scanner.

11/04 -- There were some issues using the updated software where the scan was not picking up all of the views of the object as the turntable was turning time for the following week to try again. I needed to complete the lab training and pay the materials fee before the next meeting to be allowed to use the s

11/08 -- Adrienne joined me to learn how to use the 3d scanner and obtain scans for the medium and small brace pieces. The scanner was easy to use o correct settings were selected. We used the Einscan scanner which is a bench-top 3D scanner with a turntable. We had to spray our brace piece with a w because the piece is clear. The spray allowed for a clearer scan, and it was easily washed off of the piece with water and a paper towel.
A few pictures of the scanning process are shown below. We performed two scans of each piece and combined the scans to form one unified scan that wa

Figure 1: Computer view of the Einscan scan in progress.

Figure 2: Turntable view of scan in progress with sprayed brace piece.

TEAM Lab Materials Fee Receipt	
Received by the College of Engineering Shops Code - 12779	
For User:	Jakob Anthony Knauss
Amount:	
Date Processed:	11/04/2021
For Term:	1222 - Ending 12/31/2021

Receipt for Materials Fee (amount was $50.00)

Conclusions/action items:

- Contact manufacturer for CAD models of the mask and brace piece.
- Research how Meshlab can be used to edit the CAD file in Solidworks with desired modifications for our design.
- Obtain necessary measurements from the scan.

11/08/2021 - Meshlab Research

JAKOB KNAUSS - Dec 13, 2021, 3:43 PM CST

Title: MeshLab Research

Date: 11/08/2021

Content by: Jakob Knauss

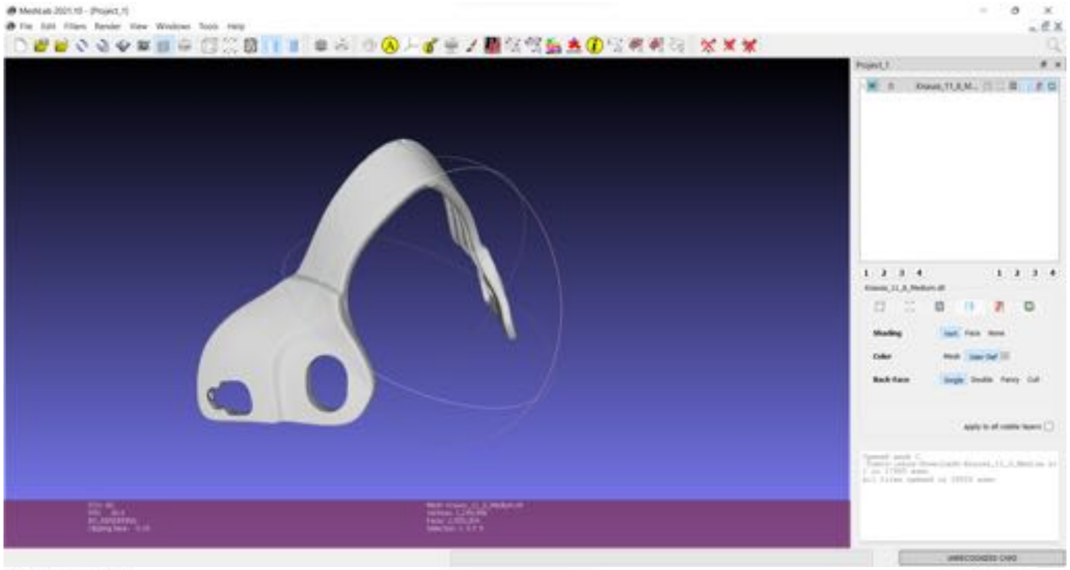
Present: N/A

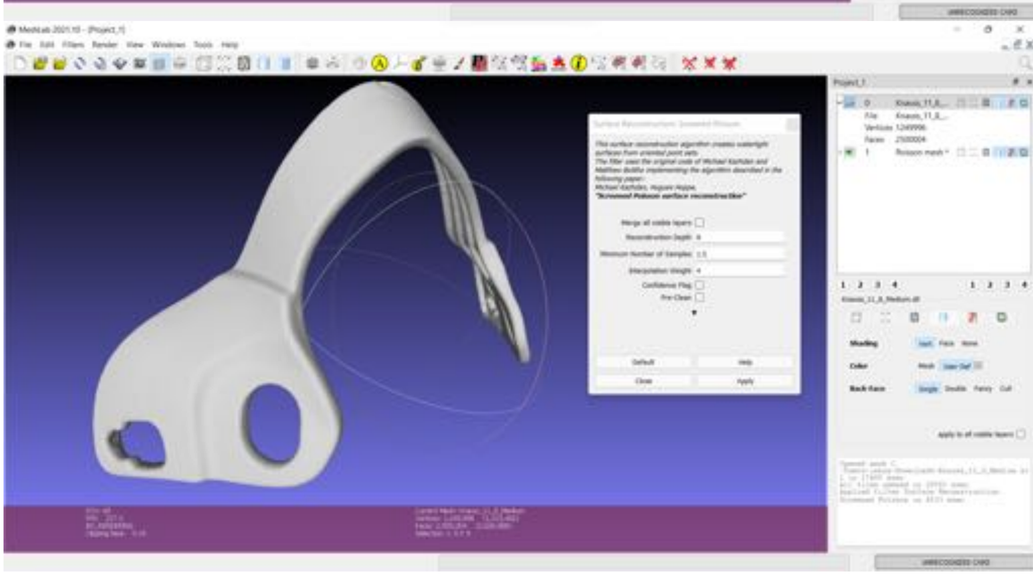
Goals: Use MeshLab to convert 3D scan stl file to modifiable file in Solidworks.

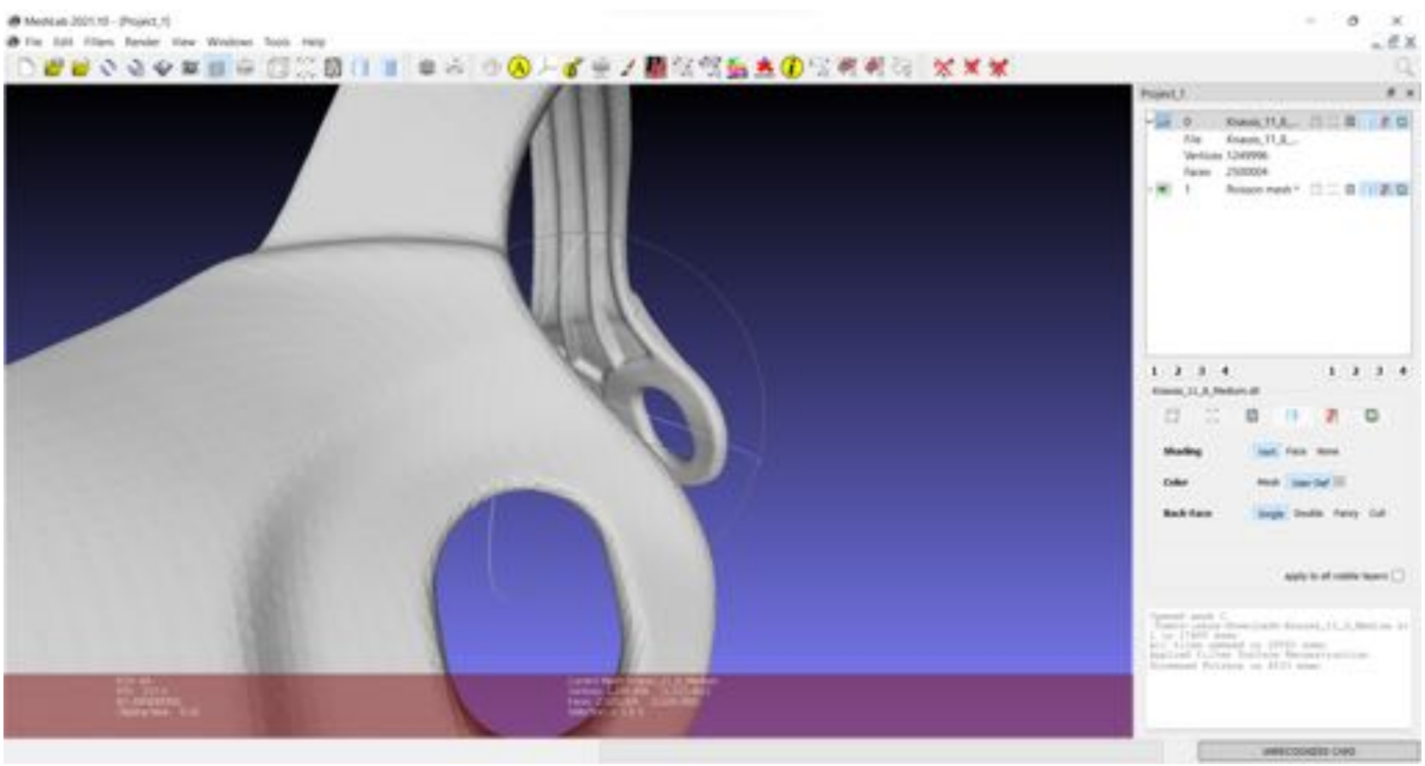
Content:

MeshLab was the recommended tool to use for translating the stl 3D scan file to a part that is able to be modified in Solidworks. I did some research and trial and error to try and convert our scan using MeshLab. Unfortunately, I was unable to obtain any promising result. Whenever, I tried to export the body from MeshLab, the application and computer would crash. It is possible that our scan was too detailed, so there were too many triangles making the file too big. My team last year when I was in BME 200 had similar issues. I investigated some of the resources linked before to see how to use MeshLab since I didn't have any previous experience. A few notes are listed here:

- MeshLab processes and modifies triangular meshes
- We want to convert our scan stl file (which is a bunch of points in space) into a mesh that can be imported into Solidworks and modified
- Poisson surface reconstruction from 3D scanning
- Implicit surface approaches that use the input data to build an implicit representation and then polygonalize it using marching cubes variants
    - Poisson surface reconstruction algorithm: builds a watertight hole-free surface filling with an interpolatory surface all the missing parts
    - *Surface Reconstruction Poisson in MeshLab
    - "Surface Reconstruction: Screened Poisson"
    - Issues exporting...
- Variables can be adjusted for more or less accurate mesh
- Process shown below for creating the Poisson mesh







Links:

https://www.meshlab.net/#about

http://vcg.isti.cnr.it/Publications/2008/CCCDGR08/MeshLabEGIT.final.pdf

https://www.youtube.com/watch?v=lHKOJ1dbyJI&ab_channel=MarakiSpai

https://www.youtube.com/watch?v=dTkiPsNZg_o&ab_channel=MisterP.MeshLabTutorials

Citations:

[1] MeshLab, "MeshLab Website", Accessed: Nov. 08, 2021. [Online]. Available: https://www.meshlab.net/#about

[2] P. Cignoni, M. Callieri, M. Corsini, M. Dellepiane, F. Ganovelli, and G. Ranzuglia, "MeshLab: an Open-Source Mesh Processing Tool." Visual Computing Lab, ISTI - CNR, Pisa Italy. Accessed: Nov. 08, 2021. [Online]. Available: http://vcg.isti.cnr.it/Publications/2008/CCCDGR08/MeshLabEGIT.final.pdf

[3] Maraki Spai, Point Cloud to Mesh Reconstruction (MeshLab), (Jun. 23, 2014). Accessed: Nov. 08, 2021. [Online Video]. Available: https://www.youtube.com/watch?v=lHKOJ1dbyJI&ab_channel=MarakiSpai

[4] Mister P. MeshLab Tutorials, 3D Scanning: merging with Poisson filter, (Mar. 14, 2011). Accessed: Nov. 08, 2021. [Online Video]. Available: https://www.youtube.com/watch?v=dTkiPsNZg_o&ab_channel=MisterP.MeshLabTutorials

Conclusions/action items:

- continue to look into Meshlab issues
- ask during advisor meeting
- investigate alternative fabrication methods

11/17/2021 - Wearing Mask

JAKOB KNAUSS - Dec 13, 2021, 12:59 PM CST

Title: Wearing Mask

Date: 11/17/2021

Content by: Jakob Knauss

Present: N/A

Goals: Observe fit of mask and estimate length of extension piece.

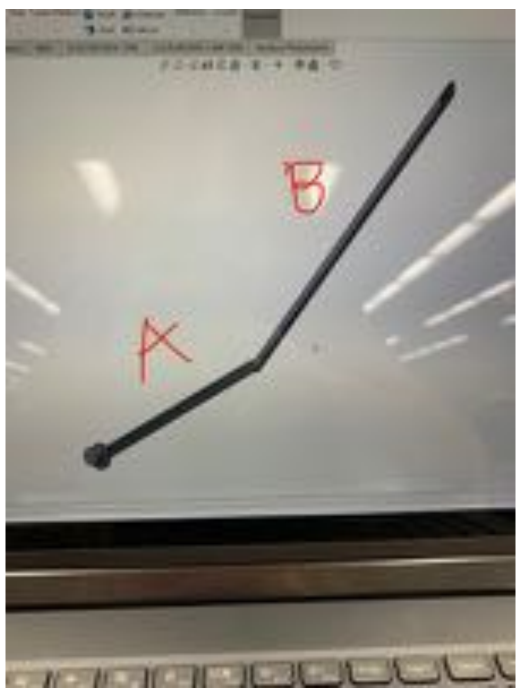
Content:

As labelled below, I estimated that the length of segment A should be about 25 mm and segment B should be about 55 mm. It was hard to make these measurements while wearing the mask, so these values may need to be adjusted through trial and error, but it is a good starting point.

Conclusions/action items:

- use extension piece length for CAD model and 3d print

JAKOB KNAUSS - Dec 13, 2021, 12:57 PM CST



56B27BA3-9BDB-4A53-BF0B-1B75E2D34BE9.jpg(492.2 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:51 PM CST

67DF72F7-3A27-4D17-83D5-74AD2BD55467.jpg(346.8 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:51 PM CST

27AF2278-E774-438E-92AF-CEB9BE1EB18F.jpg(440 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:51 PM CST

,

32211B21-4EFF-4D96-B281-9ED94E92FE22.jpg(381.4 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:51 PM CST

,

6811DDB0-23CC-4745-B081-3D50F68327C3.jpg(436.7 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:52 PM CST

,

B812BC10-5804-4863-8C69-4B6C42EB2531.jpg(295.9 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:52 PM CST

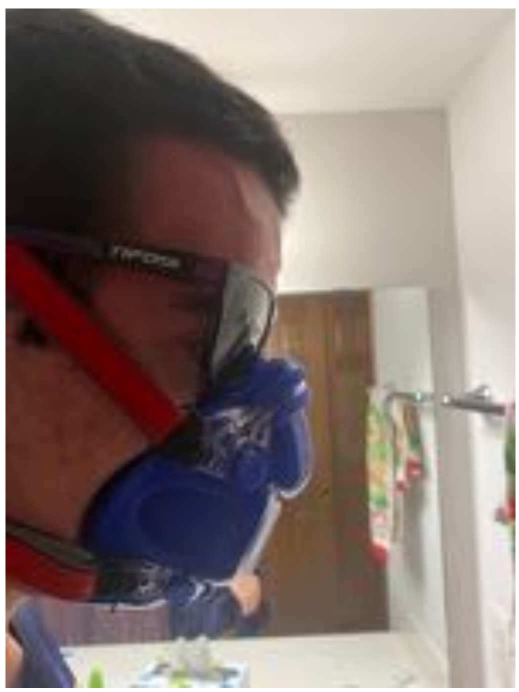
,

DC46278D-1024-480C-9659-7299F48E7050.jpg(320.7 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:52 PM CST

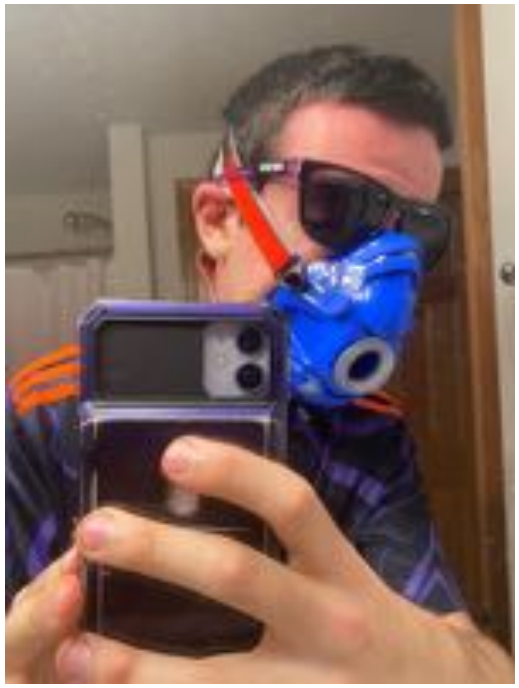
2060487D-BE89-4FCB-A999-AD250D09FE85.jpg(417.9 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:53 PM CST



B0F9F6DF-678F-43A1-9F5C-509034FE3EEA.jpg(342.1 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:53 PM CST



9E008B30-85F7-4328-9B29-4BBEE8877CF4.jpg(382 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:53 PM CST

4BA27284-B890-45A4-AC57-6E1DF8C377D8.jpg(470.1 KB) - download

11/22/2021 - 3D Printing Extension Pieces w/ Adrienne

JAKOB KNAUSS - Dec 13, 2021, 1:02 PM CST

Title: 3D Printing Extension Pieces w/ Adrienne

Date: 11/22/2021

Content by: Jakob Knauss

Present: Adrienne

Goals: 3D print first physical prototype of extension piece.

Content:

3D Printing Details:

- Date: 11/22
- Cost: $0.68
- Material: Ultimaker PLA
- Color: Red

Adrienne and I went to the Makerspace to 3D print our first physical prototype of the extension pieces. Adrienne created the CAD model for the extension pieces (shown below) with input from the team and based on the physical measurements of the existing masks supplied by Johnson Health Tech. We drilled a hole in the 3D-printed brace piece (from the 3D scan) for the extension piece to insert into. Functionally, the extension piece inserts and stays in the hole very well. The only issue was the shorter edge of the piece was too long, so it blocked the corner of the user's vision a little bit. We will reprint with this edge shorter. Then, the piece should be good to test functionally with the Velcro and glasses.

Conclusions/action items:

- test connection with 3D printed brace piece
- make necessary adjustments and 3D print another model for functional testing

JAKOB KNAUSS - Dec 13, 2021, 1:02 PM CST

B9F72F2D-A509-4622-BFA9-BBAA0C1D2D08.jpg(329.3 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 1:03 PM CST

5D1F8281-D635-4098-A972-B1F40A77663F.jpg(471.7 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 1:03 PM CST

DB6C94DF-895C-4FB5-9153-8A1887B2FD5A.jpg(384 KB) - download

JAKOB KNAUSS - Dec 01, 2021, 4:46 PM CST

F2C7A21E-FEDE-4CFF-A0B8-9E1A6B56F715.jpg(207.5 KB) - download 3D Printed Extension Piece

JAKOB KNAUSS - Dec 01, 2021, 4:47 PM CST

504BA41B-972E-4297-AB90-FA428DFBD5E1.jpg(619.8 KB) - download 3D Printed Extension Piece

JAKOB KNAUSS - Dec 01, 2021, 4:48 PM CST

9B0BD49A-25D3-4654-A673-486DCB2BB060.jpg(698.8 KB) - download Printed Pieces Attached to Structural Brace

JAKOB KNAUSS - Dec 01, 2021, 4:48 PM CST

AC2E3AFA-3D23-469F-8219-BA2F56856269.jpg(543.7 KB) - download Printed Pieces Attached to Structural Brace on Mask

JAKOB KNAUSS - Dec 01, 2021, 4:48 PM CST

A2AB047C-CAF3-40CD-9C31-67A61819C040.jpg(552.9 KB) - download Printed Pieces Attached to Structural Brace on Mask

JAKOB KNAUSS - Dec 01, 2021, 4:49 PM CST

,

Receipt.jpg(680.1 KB) - download 3D Printing Receipt

12/1/2021 - 3D Printing Extension Pieces w/ Rachel

JAKOB KNAUSS - Dec 13, 2021, 3:50 PM CST

Title: 3D Printing Extension Pieces w/ Rachel

Date: 12/1/2021

Content by: Jakob Knauss

Present: Rachel

Goals: 3D print modified extension piece.

Content:

3D Printing Details

- Date: 12/1
- Cost: $0.56
- Material: Ultimaker PLA
- Color: Black

Adrienne updated the CAD model with a decreased length of the shorter edge of the extension piece. A drawing with measurements is shown below. The first iteration we printed were able to insert and stay in the holes drilled into our 3d printed resin brace piece. The only issue was that the extension pieces blocked some of the user's vision, so decreasing the length of the shorter edge (protrusion) should fix this issue. We should be able to begin functional testing with this prototype.

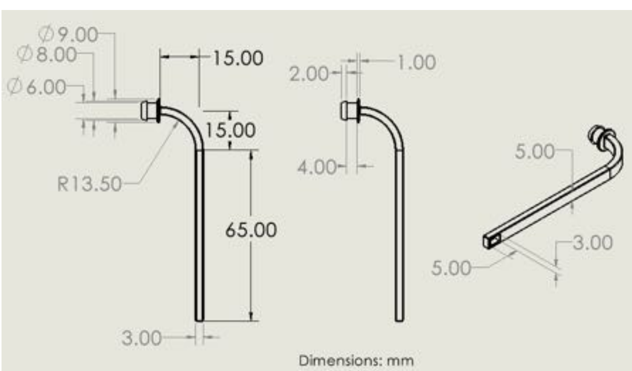


Figure 1: Final extension piece prototype dimensions.

Conclusions/action items:

- verify that user's view is not blocked as much as with first prototype
- execute functional testing and prepare final deliverables

JAKOB KNAUSS - Dec 13, 2021, 12:27 PM CST

,

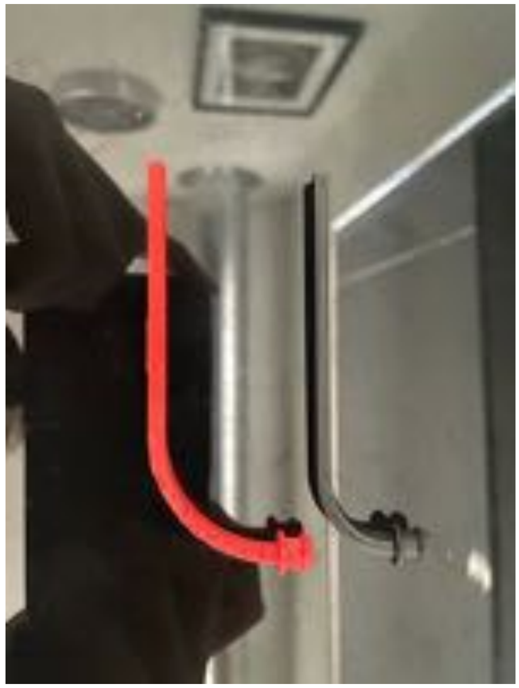
90AA6B2A-7F65-43C8-9182-544BAC5C2D41.jpg(695.4 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:27 PM CST

,

AF96F73B-6072-4A28-AA84-A216B8B750C9.jpg(851 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:27 PM CST

,

2FBD67F2-E132-411C-B470-D95F76E7117B.jpg(525.9 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:28 PM CST

,

9E5DBD68-F819-4956-91D4-DA1D47268661.jpg(528.7 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:28 PM CST

EB8837CD-26BA-410C-8BDC-6782F80F4999.jpg(378.4 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 12:28 PM CST

Receipt.jpg(652.3 KB) - download

12/5/2021 - Testing Data and Statistical Analysis Calculations

JAKOB KNAUSS - Dec 13, 2021, 2:22 PM CST

Title: Statistical Analysis Method for Discrete Data

Date: 12/5/2021

Content by: Jakob Knauss

Present: N/A

Goals: Perform statistical analysis and plot collected data.

Content:

- See previous entry discussing Wilcoxon Signed Rank Test and Sign Test
    - We did not have a large enough sample size to run either test, but a description of how each would work and some simple calculations can be found in the document below
- I took the raw data collected during tested, organized it, and created bar graphs to visualize survey results
- We recognize that no conclusions can be drawn because no statistical analysis can be run, but it is useful to visually see the trends in responses

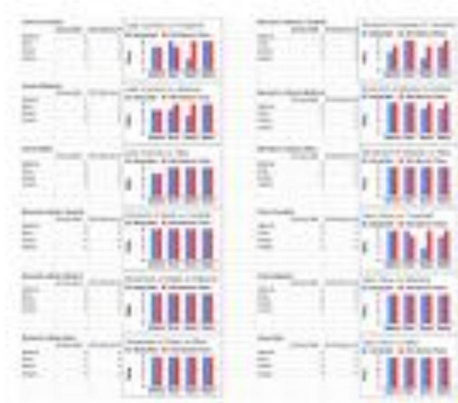
Conclusions/action items:

- Use this analysis and results information in the final poster and report

JAKOB KNAUSS - Dec 13, 2021, 2:25 PM CST

Testing_Data_and_Analysis.pdf(152.6 KB) - download

JAKOB KNAUSS - Dec 13, 2021, 2:32 PM CST



Testing_Bar_Graphs.pdf(374.1 KB) - download

Biosafety Training and Chemical Safety Training

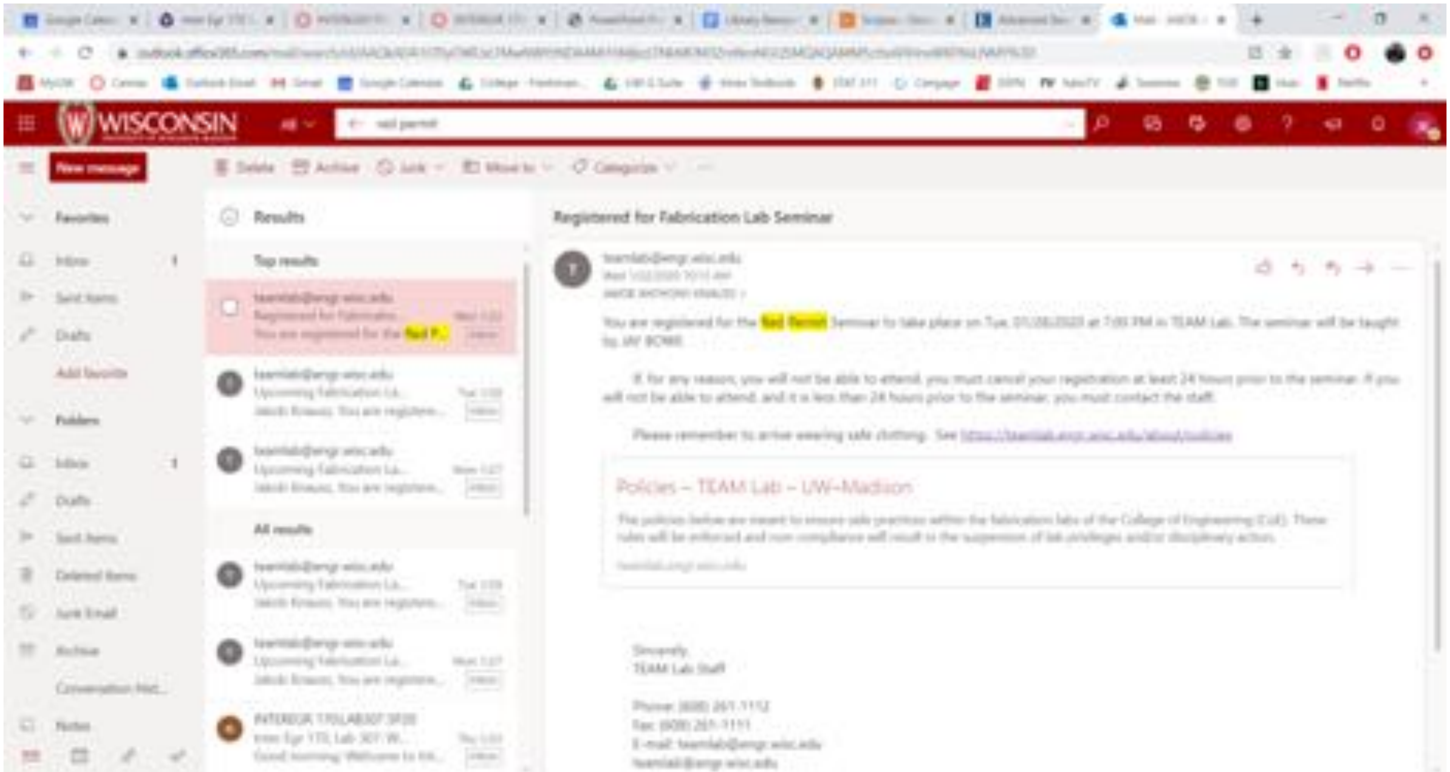
JAKOB KNAUSS - Mar 30, 2021, 2:29 PM CDT


University of Wisconsin-Madison

Certificate_of_Completion_for_JAKOB_KNAUSS.pdf(135.8 KB) - download

Red Pass (Spring 2020)

JAKOB KNAUSS - Feb 02, 2021, 9:39 AM CST



CITI Human Subjects Research Training Certification

JAKOB KNAUSS - Nov 28, 2021, 10:32 PM CST

citiCompletionReport10679428.pdf(410.3 KB) - download CITI Human Subjects Research Training Certification

9/17/2021 Smartphone-Based VO2max Measurement

ADRIENNE RASMUSSEN - Sep 17, 2021, 7:44 PM CDT

Title: Smartphone-Based VO2max Measurement With Heart Snapshot

Date: 9/17/2021

Content by: Adrienne Rasmussen

Present: Adrienne Rasmussen

Goals: To understand a study that performed a different approach to obtaining VO2 max measurements

Content:

https://mhealth.jmir.org/2021/6/e26006/

- VO2 max can be defined as ones' maximal oxygen consumption and is the most predictive biometrics for cardiovascular health and overall morality

- VO2 max is rarely measured in large-scale research studies or routine clinical care because of the high cost, participant burden, and requirement for specialized equipment and staff.

Objective: Aim to develop a digital VO2 Max estimation protocol that can be self-administered remotely using only the sensors within a smartphone. Also tried to validate the measurements within a broad population across a spectrum of smartphone devices.

Methods:

- Two smartphone-based VO2 max estimation protocols were developed: a 12-minute run test and a 3-minute step test

- Participants completed gold standard treadmill-based VO2 max measurement, two silver standard clinical protocols, and the smartphone-based 12-MRT and 3-MST protocols in the clinic and at home

Results:

- Both the 3-MST and 12-MRT had high test-reliability

- Performance did not correlate with device cost

Conclusions/action items:

Understand what VO2 max testing is used for/why it is important

Evaluate the different approaches to obtaining VO2 max

9/17/2021 Study of VO2 Max

ADRIENNE RASMUSSEN - Sep 17, 2021, 8:07 PM CDT

Title: A study of VO2 Max and Body Fat Percentage in Female Athletes

Date: 9/17/2021

Content by: Adrienne Rasmussen

Present: Adrienne Rasmussen

Goals: To better understand what VO2 max testing signifies and what it is dependent upon

Content:

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4316241/

- body fat percentage affects VO2 max and thus cardiovascular status

- VO2 max refers to the intensity of aerobic process and actually denotes the maximum capacity to transport and utilize oxygen during exercise done at increasing intensity

- VO2 max is the highest rate of oxygen consumption attainable during maximal exercise

- Reflects physical fitness of an individual having athletic capacity

- The basic unit of measuring the maximal oxygen uptake is it's absolute value expressed in liters or ml per minutes

- The reduction in the physical activity affects body composition factors and aerobic, cardiovascular fitness

- With decrease in body fatness, there is an increase in aerobic fitness

- There is an alarming decline in physical activity among college students

- 35% of young adults are overweight or obese

- Study aimed to assess the relation of VO2 max and body fat percentage

Methods:

- 25 female athletes of ages 17-22 selected for the study

- VO2 max was determined by Queen's college step test and body fat percentage by calipers

Results:

- Mean VO2 max in the athletic group was 39.62 +- 2.8 ml/kg/min. In non-athletic group the VO2 max was 23.54+- ml/kg/min

- The mean body fat percentage in athletes was 24.11 +- 1.83% and in the non-athletes it was 29.31+-3.86%

- Difference in VO2 max and body fat percentage was statistically significant in the study

- VO2 max and body fat percentage in both groups showed negative correlation by Pearson test, but not statistically significant

Conclusion:

- The present study showed a statistically significant higher VO2 max in female athletes

- Negative correlation between VO2 max and body fat percentage

Conclusions/action items:

Review why VO2 max testing is important

Grasp what the purpose of the mask we are making

Now can assess what factors affect VO2 max

10/7/2021 Average Facial Measurements

ADRIENNE RASMUSSEN - Oct 07, 2021, 10:31 AM CDT

Title: Analysis of Human Head Shape

Date: 10/02/2021

Content by: Adrienne Rasmussen

Present: Adrienne Rasmussen

Goals: To grasp an idea of the average head shapes to develop our mask

Content:

- The purpose of this study was to provide accurate head dimension data for developing safety head products

- Measurements taken: menton-top of head, head breadth, head thickness, tragion-top of head, bitragion breadth, bizygomatic breadth, bitragion coronal ac, head circumference, bitragion submandibular arc, head breadth & thickness ration, and menton top of head & bizygomatic breadth ratio

- There are a list of measurement methods for each measurement taken

<Table 4> Basic Statistics

Scale: cm, kg

No	Dimensions	Mean	St. Dv	Min.	Max.
1	Height	176.2	9.7	152.4	198.1
2	Weight	80.6	15.0	54.4	136.1
3	Menton-top of head	24.1	2.5	19	29.1
4	Head breadth	14.5	1.3	10.2	17.4
5	Head thickness	19.4	2.5	13.8	23.9
6	Tragion-top of head	14.2	1.5	11	16.9
7	Bitragion breadth	13.2	1.7	9.4	16.8
8	Bizygomatic breadth	13.9	1.2	11.1	16.8
9	Bitragion Coronal Arc	38.0	2.3	34	43.5
10	Head circumference	57.4	2.1	53.4	61.6
11	Bitragion submandibular arc	29.9	2.9	25	35.8
12	Head breadth & thickness Ratio	76.4	13.4	48.5	110
13	Menton top of head & bizygomatic breadth Ratio	174.5	22.3	129.2	231.5

- 105 American's men's head shapes were analyzed in this study and the following factors and characteristics were found: american men have long menton-top heads but narrow head breadth

- 54.3% of the 105 American men studied had narrow faces and large head circumferences

<Table 8> Result of Duncan Test

Dimensions	Type 1		Type 2		Type 3		Type 4		F Value	Duncan Test
	Mean	St. Dv	Mean	St. Dv	Mean	St. Dv	Mean	St. Dv		
Height	176.3	9.2	174.6	11.6	175.0	9.7	178.1	9.2	0.6	Type2 = Type 3 = Type 1 = Type 4
Weight	80.8	15.1	78.4	15.9	79.0	14.9	83.4	14.7	0.6	Type2 = Type 3 = Type 1 = Type 4
Menton-top of head	24.7	3.0	26.0	1.9	22.1	1.6	24.6	1.6	13.7***	Type3 < Type 4 = Type 1 < Type 2
Head breadth	15.5	0.7	14.1	1.4	13.7	1.3	14.2	1.1	14.2***	Type 3 = Type 2 = Type 4 < Type 1
Head thickness	18.9	3.0	18.1	3.0	20.5	2.0	19.7	1.7	4.0*	Type 2 = Type 1 ≤ Type 4 ≤ Type 3
Tragion-top of head	15.0	1.2	13.9	1.5	14.2	1.4	13.6	1.5	5.9**	Type 4 = Type 2 = Type 3 < Type 1
Bitragion breadth	15.0	0.9	12.8	1.5	12.5	1.4	12.1	1.4	30.8***	Type 4 = Type 2 = Type 3 < Type 1
Bizygomatic breadth	15.1	0.6	14.0	1.0	13.4	1.2	13.1	0.7	30.5***	Type 4 = Type 2 = Type 3 < Type 1
Bitragion Coronal Arc	36.8	1.8	41.2	1.8	37.6	1.9	37.8	1.5	23.0***	Type 1 = Type 3 = Type 4 < Type 2
Head circumference	57.9	1.7	56.0	2.1	56.1	1.9	59.1	1.3	19.3***	Type 2 = Type 3 < Type 1 < Type 4
Bitragion submandibular arc	30.4	2.9	31.1	3.4	29.7	2.9	28.8	2.4	2.7	Type 4 = Type 3 = Type 1 = Type 2
Head breadth & thickness Ratio	85.2	13.6	79.6	14.5	67.7	9.3	73.6	9.5	12.4***	Type 3 ≤ Type 4 ≤ Type 2 ≤ Type 1
Menton top of head & bizygomatic breadth Ratio	163.0	18.2	187.4	23.0	166.0	20.4	189.0	15.9	13.6***	Type 1 = Type 3 < Type 2 = Type 4

*: $p<.05$, **: $p<.01$, ***: $p<.001$

- The tables included can be useful if one refers to the article to define each type

Citation: Lee, Jin-Hee & Shin, Su-Jeong & Istook, Cynthia. (2006). Analysis of Human Head Shapes in the United States. International journal of human ecology. 7.

Link: https://www.researchgate.net/publication/264024487_Analysis_of_Human_Head_Shapes_in_the_United_States

Conclusions/action items:

- This article is useful for men's head shapes in the United States, which is relevant to our mask because that is part of the population that will be wearing the mask

- This article is not the most adequate but I thought it was important because they included precise methods of measuring people's faces which could be useful

- Must continue research to observe women's head shapes

- Evaluate the masks we already have and compare sizing to research findings

10/07/2021 Quantification of Facial Traits

ADRIENNE RASMUSSEN - Oct 07, 2021, 10:48 AM CDT

Title: Quantification of Facial Traits

Date: 10/07/2021

Content by: Adrienne Rasmussen

Present: Adrienne Rasmussen

Goals: Identify methods to quantify components of face that are important to consider for mask dimensions

Content:

- Divided process of measuring facial traits into the registration of the face, landmarking, morphometric quantification, and dimension reduction

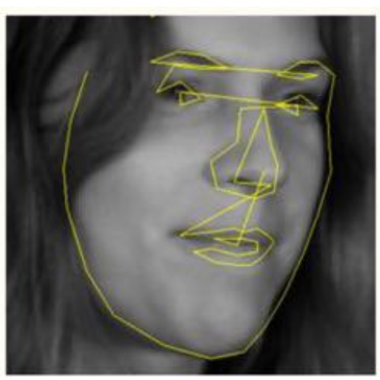
- Face registration is the process of standardizing pose. The definition of the standard pose is method specific. For example, nose, eyes, and mouth all offer possibilities for such definitions by aligning them to pre-specified locations.

- Landmarking annotates positions in the face with anatomic description of mathematically defined properties. This entails searching or locations on a given representation of a face corresponding to locations on a second such representation, or alternatively to those on an idealized face

- Morphometric quantification computes pre-specified transformations such as distances

- This review focuses on 3D surface data as captured by commercial surface scanners but also cover methods for 2D facial pictures

- Active contour models place a graph on an image and try to align it with existing edges (example shown below)



- If a proposed shape is too unlikely, it is moved back to the closest point in the acceptable region

- Symmetry estimation addresses an important aspect of facial data. The degree of symmetry is an important property of a face having a connection with attractiveness and an impression of dysmorphia which in turn is linked with genetic syndromes

- Link: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6543276/

Conclusions/action items:

- Determine what the "standard position" of a face while participating in a VO2 max test is

- Evaluate the masks that we were given based on the methodology of taking facial measurements in this article

- Observe how the current mask fits faces and if it is adequate

9/17/2021 Competing Design

ADRIENNE RASMUSSEN - Sep 17, 2021, 7:24 PM CDT

Title: Competing Designs of VO2 Max Masks Commercially Available

Date: 9/17/2021

Content by: Adrienne Rasmussen

Present: Adrienne Rasmussen

Goals: To obtain a general idea of what other VO2 max masks are commercially available.

Content:

VO2 Master Pro

https://store.simplifaster.com/product/vo2-master-pro/

Strengths:

- Advertised as the world's most portable, affordable, and easy-to-use VO2 analyzer

- Free phone app that allows or Bluetooth data collection and easy sharing

- Can provide details to help determine a variety of areas that would benefit from specific training intensities

Package Includes: VO2 Master Pro unit, Hard shell case, Small mask, RMR user piece, Medium user piece, Large user piece, 50 filters, 5 AAA batteries, Quick Start Guides

This product is not intended for any medical use, it is intended to be used in sport

Korr Medical Technologies Inc. CardioCoach

https://korr.com/products/vo2-max-testing-system/

Strengths:

- Advertised as simple to use with user interface that has wireless connections

- No training or ceritfication required

- 3% error in VO2 max measurements

- The equipment is feasible for gym owners and trainers at any level of expertise

- Has CardioCoach app to guide clients through workouts for goals custom designed by their results

- Been independently validated at USC and Oregon State University

There are four different models available: CardioCoach, CardioCoach Plus, CardioCoach Max, and CardioCoach Pro

Conclusions/action items:

Examine and evaluate their designs for the VO2 max mask

Compare these to the Johnson Health design

State any obvious ways to alter the mask to better accommodate glasses

10/10/2021 Mask Materials

ADRIENNE RASMUSSEN - Oct 10, 2021, 5:39 PM CDT

Title: Mask Materials

Date: 10/10/2021

Content by: Adrienne Rasmussen

Present: Adrienne Rasmussen

Goals: To do further research on materials to use for the mask.

Content:

ABS

- excellent impact, chemical and abrasion resistance

- superior stiffness and strength

- good dimensional stability

- used for plumbing parts, housings and covers, automotive instrument panels, vacuum-formed parts, bumpers, food processing components

ASA

- similar to ABS

- has better mechanical properties

- UV resistant

- used for jigs, fixtures and manufacturing aids

- low-volume production and highly customized parts

PLA

- benefit of PLA as a bioplastic is its versatility

- naturally degrades when exposed to environment

Tough 1500

- could be good for the clips because it moves slightly easier and is still strong

Name	Description	Method	Printer	Cost of Sample Print($)	Reliability	Popularity(# of Jobs)
ABS		FDM/FFF	Stratasys		9	
ABS-ESD7		FDM/FFF	Stratasys		9	
ASA		FDM/FFF	Stratasys		9	
Black		SLA	FORM		8	
Breakaway		FDM/FFF	UM		5	
Clear		SLA	FORM		8	
CPE+		FDM/FFF	UM		5	
Cyclic Olefin Copolymer		FDM/FFF	Dolomite		3	
Draft		SLA	FORM		5	
Durable		SLA	FORM		6	
Elastic		SLA	FORM		4	
Fiber		FDM/FFF	Markforged		7	
Flexible		SLA	FORM		3	
Grey Pro		SLA	FORM		6	
High Temp		SLA	FORM		5	
Nylon		FDM/FFF	UM		5	
Onyx		FDM/FFF	Markforged		7	
PC-ABS		FDM/FFF	Stratasys		9	
PLA		FDM/FFF	UM		10	
PLA		FDM/FFF	Stratasys		9	
Polycarbonate		FDM/FFF	UM		5	

Polypropolyene		FDM/FFF	UM		5	
PVA		FDM/FFF	UM		2	
QSR Support		FDM/FFF	Stratasys		8	
Rigid		SLA	FORM		5	
Surgical Guide		SLA	FORM		4	
Tough		SLA	FORM		6	
Tough 1500		SLA	FORM		6	
Tough PLA		FDM/FFF	UM		10	
TPU		FDM/FFF	Stratasys		8	
White		SLA	FORM		8	

Conclusions/action items:

- discuss with team what they think about the best material to use

- figure out if we are going to mold the mask

- finalize materials

10/28/2021 Eyeglass Sleeve For Legs of Glasses

Title: Eyeglass sleeve

Date: 10/28/2021

Content by: Adrienne Rasmussen

Present: Adrienne Rasmussen

Goals: To find inspiration for attachments to the legs of glasses

Content:

https://www.amazon.com/SMARTTOP-Eyeglasses-Anti-Slip-Sunglasses-Pairs-Clear/dp/B07R6G3SC9/ref=sr_1_2?crid=2BR5134JIOJME&dchild=1&keywords=silicone+rubber+glasses+holde

Info about product:

- Made out of soft silicone, lightweight, durable

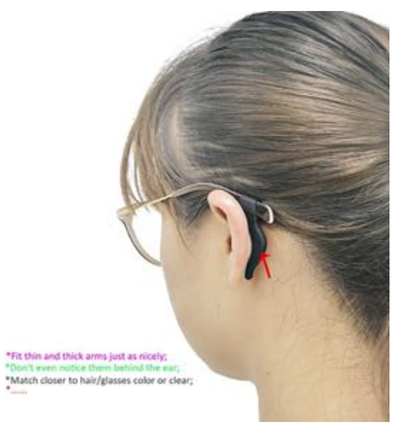
- Size: 0.6inx 0.2in. Height: 0.3in

- Fit for glasses arm width from 0.1in-0.3in

- There are three different ways to install them

- Anti-slip design

- Advertised as compatible with most types of glasses



[https://www.amazon.com/dp/B08JTS8DLK/ref=sspa_dk_detail_4?pd_rd_i=B08JTS8DLK&pd_rd_w=ZUmG0&pf_rd_p=887084a2-5c34-4113-a4f8-b7947847c308&pd_rd_wg=FGPFA&pf_rd_r=
74f2052d90e2&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUEySFdTWjFXVldPRElNJmVuY3J5cHRlZElkPUEwNzI2NjgxMVJQOTZaMEFEWFI5JmVuY3J5cHRlZFdSWQ9QTA5MjcwNDEyWkR]()

Info about product:

- Size: 4.2cm x 1.1cm x 0.25cm

- Silicone ear hook

- Anti-slip

- Fit most kids and adult size glasses or sunglasses

- Light weight

https://www.amazon.com/dp/B07YVDT3KT/ref=sspa_dk_detail_4?psc=1&pd_rd_i=B07YVDT3KT&pd_rd_w=yikFk&pf_rd_p=887084a2-5c34-4113-a4f8-b7947847c308&pd_rd_wg=nxsS1&pf_
e213e859e0fa&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUExUEpEMlc0RU43OVBJJmVuY3J5cHRlZElkPUEwNDMzODU3MVc3SUZEWTgxTU02QSZlbmNyeXB0ZWRBZElkPUEwMjc2NTQzl

Info about product:

- Fit glasses legs from 0.3-1.1 cm

- Easy to install and clean

- Made out of soft and durable stretchy silicone material

- Very comfortable

Conclusions/action items:

- Use these ideas to brainstorm our own

- Figure out if these designs have a potential to work

- How are these accommodating different leg sizes?

12/2/2021 Preparing SolidWorks Models to 3D print

ADRIENNE RASMUSSEN - Dec 02, 2021, 10:19 AM CST

Title: Preparing SolidWorks Model to 3D Print

Date: 12/2/2021

Content by: Adrienne Rasmussen

Present: Adrienne Rasmussen

Goals: To establish any adjustments I should make to the SolidWorks model before printing.

Content:

https://blogs.solidworks.com/tech/2015/05/preparing-solidworks-models-3d-printing.html

- Will be printing from an STL file (the one single format that can be output by most CAD programs and can be understood by most printing equipment)

- STL uses a series of triangles to describe outer surfaces of 3D models

- Must save as an STL file

- Settings can be modified to adjust the resolution/accuracy of the model

- If you made the triangles smaller the model will be less course than with bigger triangles

Adjusting these settings:

- In the save window, once selected "STL file" an options box will become available

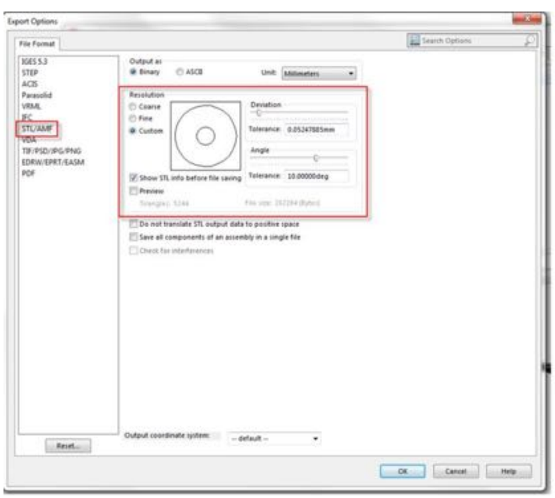
- You can save STL files in binary or ASCII

- Binary are smaller (so usually preferred), but ASCII files can be visually read and checked

- Resolution settings alter the level of coarseness or fineness that the model will be printed as

- Can control both the deviation and angle of the triangles during .stl conversion

- To adjust resolution settings:



- Choosing these settings all depends on the resolution of the printer that you're using

Conclusions/action items:

- Determine which printer you are going to use in the Makerspace

- Identify whether or not you should change settings before printing

12/2/2021 Post-Processing

ADRIENNE RASMUSSEN - Dec 02, 2021, 10:37 AM CST

Title: 3D Printing Post-Processing

Date: 12/2/2021

Content by: Adrienne Rasmussen

Present: Adrienne Rasmussen

Goals: Identify if any post-processing procedures are necessary with our part.

Content:

https://all3dp.com/2/fdm-3d-printing-post-processing-an-overview-for-beginners/

3D Printing Post-Processing

Support Removal

- removing the supports off of the piece

- likely use knife or pliers

- is necessary in any print

- be careful not to damage the piece itself

Sanding

- likely will need to do as well

- smooths out part

- great to do before polishing or painting (if we do this)

Priming and Painting

- preparing a surface for painting

- pros of this are it enhances the look and feel, provides a smooth finish

Smoothing

- pour acetone into a large container then place prints on a platform above the acetone and close the container for 10-20 minutes

- this will melt off the outer layer of parts

- pros are that it smooths and makes shiny, acetone is also cheap

Polishing

- this is done to achieve the smoothest possible surface

-inexpensive to do

Conclusions/action items:

- Examine the piece after it has been printed and decide what post-processing will need to be done

- I would imagine that at least we will need to sand the piece to make it smoother

- Could be a good idea to add some polish to make it look more complete, but figure out if that is necessary

12/8/2021 Testing Recap

ADRIENNE RASMUSSEN - Dec 08, 2021, 12:57 PM CST

Title: Recap of Testing at Fitness Center

Date: 12/8/2021

Content by: Adrienne Rasmussen

Present: Adrienne Rasmussen

Goals: To summarize testing

Content:

Without Extension Pieces

- Glasses did not move much on elliptical or stationary bike, but still noticeable

- Glasses were extremely distracting on treadmill and bouncing up and down

- Impaired vision on treadmill

- Treadmill was the most noticeable in regards to movement of glasses

- Comfort was decent on the elliptical and bike, but not very good on treadmill

- Mask was secure on all three machines

- Vision only really saw a difference on the treadmill

With Extension Pieces

- Movement of glasses was completely eliminated on all three machines

- Felt very secure and was comfortable because I was not worried about movement

- There was not a significant change in comfort

- Overall vision improved

- Noticeable difference with the extension pieces added

- They did not block vision at all

Conclusions/action items:

Compare these results with team

Evaluate what this means in regards to the extension pieces

9/28/2021 Other Masks Accommodating Glasses

ADRIENNE RASMUSSEN - Sep 28, 2021, 4:35 PM CDT

Title: Other types of masks accommodating glasses

Date: 09/28/2021

Content by: Adrienne Rasmussen

Present: Adrienne Rasmussen

Goals: To research how other people have accommodated glasses into masks

Content:

Conclusions/action items:

Assess these images

All of the masks I have found simply just have the space to wear glasses above the mask. This could indicate that we do not need to add anything to the mask but just tweak the sizing on the part of the mask that covers the nose

09/28/2021 Initial Ideas

ADRIENNE RASMUSSEN - Sep 28, 2021, 4:23 PM CDT

Title: Initial Mask Ideas

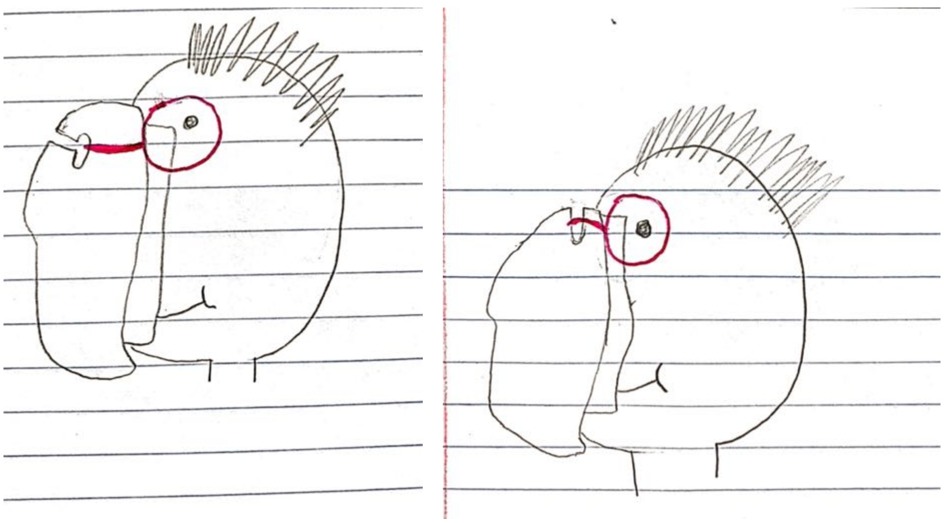
Date: 09/28/2021

Content by: Adrienne Rasmussen

Present: Adrienne Rasmussen

Goals: To come up with an initial idea of how to go about accommodating glasses into the mask

Content:



My instinct for designing this mask is to do a slot mechanism where the bridge of the glasses can slide into and securely fit.

Conclusions/action items:

Continue to brainstorm other designs

Look at images to inspire designs

Converse with group about there designs

10/07/2021 Mask Design With Center Clip

ADRIENNE RASMUSSEN - Oct 07, 2021, 12:35 PM CDT

Title: Glasses attachment on centerpiece

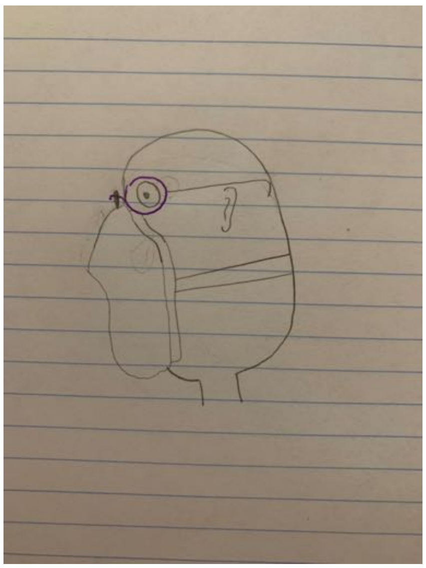
Date: 10/07/2021

Content by: Adrienne Rasmussen

Present: Adrienne Rasmussen

Goals: To design a mask that secures to the glasses on the center bridge of the nose

Content:



Conclusions/action items:

- This design was intended to make it easier to secure the glasses because the only place that will consistently be the same on every pair of glasses is the center

- Evaluate if this is a reasonable and plausible design

- Test idea with glasses

12/8/2021 Final Design of SolidWorks Part

ADRIENNE RASMUSSEN - Dec 08, 2021, 12:50 PM CST

Title: SolidWorks Model of Extension Piece

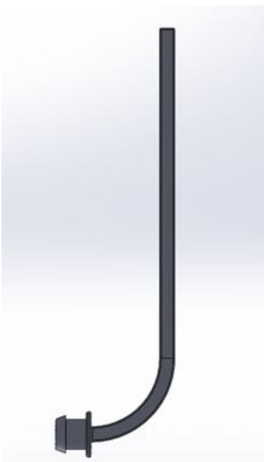
Date: 12/8/2021

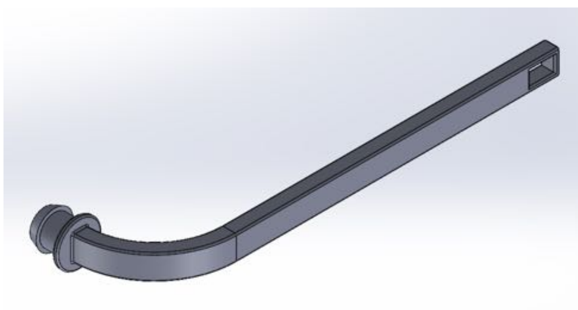
Content by: Adrienne Rasmussen

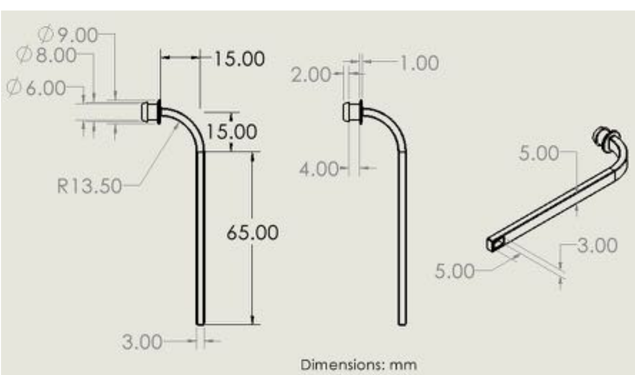
Present: Adrienne Rasmussen

Goals: To document the SolidWorks model

Content:







Conclusions/action items:

Add this design to final presentation and poster

Sept. 16, Eyeglasses Frame Size Chart & Guide - Ray Ban

THOMAS KRIEWALDT - Oct 13, 2021, 12:55 PM CDT

Title: Eyeglasses frame size chart and guide

Date: 9/16/21

Content by: Tommy Kriewaldt

Present: N/A

Goals: To develop an elementary understanding of basic dimensions we will be using in our product

Sources:

[1] “HOW DO I FIND THE FRAME SIZE OF MY RAY-BAN SUNGLASSES AND EYEGLASSES?” Size Guide, Ray Ban Sunglasses, www.ray-ban.com/usa/size-guide. *Google Search: 'sizing guide glasses size chart.'*

Content:

While this is not a scholarly article, it gives important context into the dimensions of a typical pair of glasses. It is published by the company, Ray Ban, in order to help their customers pick out the right size for their products.

It lists out the industry standard practice of labeling each pair of glasses with a three number code, corresponding to the width and diameter of the lens, the bridge width, as well as the length of the temple. These three things combine to form this "code" like this: 50-40-130.

The article also states that the average width of the bridge is around 12-26 mm in length, from left lens to right lens. This is useful because our team can now build a rough prototype for holding up the bridge of the glasses given the approximation.

- Our client stated that we should be building this product for all sizes of glasses, so we should use the 26 mm measurement into consideration.

Conclusions/action items: While this article didn't offer too much information, it helped our group to understand the realm of dimensions we will be working with in this project. We should take more refined measurements of physical pairs of glasses to ensure that our design will be able to fit more than one size.

Sept. 30, Silicone Molding Fabrication

THOMAS KRIEWALDT - Sep 30, 2021, 3:07 PM CDT

Title: Silicon Molding Resins

Date: 9/30/21

Content by: Thomas Kriewaldt

Present: N/A

Goals: To establish a better understanding of how we will create and design the base of our mask.

Sources:

[1] Homeyer, H N, et al. “Pubs-Acs-Org.ezproxy.library.wisc.edu.” *Silicon Molding Resins*, Connecticut Hard Rubber Corporation, https://pubs-acs-org.ezproxy.library.wisc.edu/doi/pdf/10.1021/cr900362e.

Content:

This source details silicone use in electronics, with numerous tables and charts depicting its insulation factors as well as some thermal properties of the silicone [1]. This isn't particularly helpful in the creation of our product, but it does help in a few areas.

First off, the induction values, although not valuable in their original use, are still useful to us in this project. Figure 10 shows us that in prolonged exposure to extreme humidity (100%) and extreme heat (70°C), the silicone structure holds up. This is valuable because our mask will be exposed to lots of airborne sweat causing humid conditions in an already hot mask. Since silicone can hold up to these conditions and more, it means that we can use the silicone as the primary material for our mask.

Lastly, it doesn't detail, but outlines a molding process for silicon. They describe a molding cycle process that is similar to that used to create phenolic compounds. Unfortunately, this source doesn't detail this process, so I will need to research further to understand this process, and how our team should go about creating the silicon base.

Conclusions/action items:

This source didn't offer me the insight I hoped to gain, however, it gave me a little bit of knowledge that will help me research further into the molding. However, I learned that we should use silicone inside of our mask design, as it can withstand the harsh conditions inside of a VO2 mask during testing.

Oct. 3, Facial Measurement Analysis

THOMAS KRIEWALDT - Oct 05, 2021, 7:05 PM CDT

Title: A HEAD-AND-FACE ANTHROPOMETRIC SURVEY OF U.S. RESPIRATOR USERS

Date: 10/3/21

Content by: Thomas Kriewaldt

Present: N/A

Goals: To get a better idea of the dimensions we have to build around for this project

Sources:

[1] Zhuang, Ziqing, et al. Anthrotech, Yellow Springs, OH, and NIOSH/NPPTL, Pittsburgh, PN, 2004, *A HEAD-AND-FACE ANTHROPOMETRIC SURVEY OF U.S. RESPIRATOR USERS* - Final Report, https://www.nap.edu/resource/11815/Anthrotech_report.pdf. Accessed 3 Oct. 2021, *Google Scholar*.

[2] Wang, Eric Min-yang, and Wei-Ching Chao. "Image of Common Measurements Taken on the Face." In Searching for Constant Body Ratio Benchmarks, Volume 40, Issue 1, Pages 59-67, Science Direct, Jan. 2010, https://www.sciencedirect.com/science/article/abs/pii/S0169814109001048. Accessed 5 Oct. 2021, *Google Scholar.*

Content:

This is an old study on the dimensions of the average human face. It details different features on the face in millimeters in the chart [1, pg. 15-18]. Each measurement of something is also outlined in the study. [1, pg. 14]. It uses computer software to analyze facial scans and assign measurements using 3D points of the face. This is a somewhat advanced method of measurement, but it yields accurate results. Useful information will be detailed in personal analysis below.

We can look at some of the measurements in this study for use in outlining our own project. For example, this report outlines on Table 8, that the average nose breadth width of a *male* human is around 36.6 ± 4.1 mm [1, pg. 15]. This is important because we now have a measurement to help tailor our design to fit the widest area of the nose. In this same table, we can spot that the average nose breadth width of a *female* human is around 33.2 ± 3.9 mm [1, pg. 17].

Other useful information detailed in the chart [1 pg. 15, 17] include:

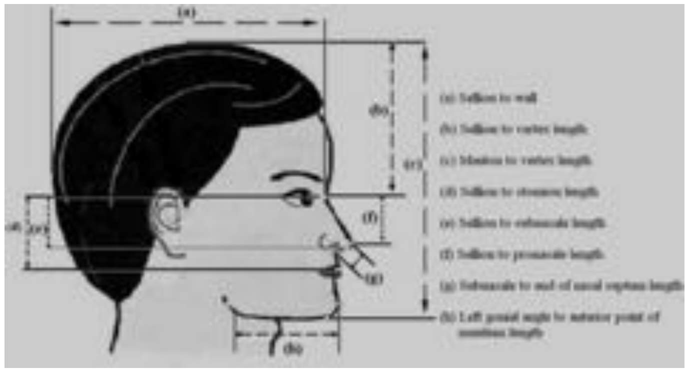
- Head Circumference - *Males*: 575.7 ± 17.1 mm, *Females*: 554.4 ± 17.8 mm.
- Nose Protrusion - *Males:* 21.1 ± 2.7 mm, *Females:* 19.8 ± 2.7 mm.
- ***Nasal Root Breadth*** - Males: 16.6 ± 2.3 mm, Females: 16.3 ± 2.0 mm.
- ***Subnasale to Sellion Length*** - *Males:* 52.0 ± 4.1 mm, *Females:* 48.2 ± 3.8 mm.
    - The "Subnasale to Sellion Length" measurement is defined in the source below [2].

These measurements are very helpful in understanding the dimensions of our project. For example, we can take the measurement of "Nasal Root Breadth" above, and apply it to our design in the dimensions our our nose bridge attachment. Given the measurement is around 20.5 mm on average between the genders, we can say that our nose bridge must fit comfortably near this range. The attached glasses will have a slightly larger width (in mm) to this measurement, so we can cross compare this data with physical dimensions of eyeglasses to get a precise range for how big the divot in our mask will be. In addition, we can analyze the "Subnasale to Sellion Length" measurement and dimension our mask to fit this length vertically on the face.

Conclusions/action items:

As already stated above, this data is very helpful into the dimensions we have to build around for this project. We should take these measurements into account when building our Solidworks/AutoCAD model for our VO2 mask. Now that we have some data on this subject, we can begin to model our preliminary design.

THOMAS KRIEWALDT - Oct 05, 2021, 6:50 PM CDT

,

FaceMeasurements.jpg(44.9 KB) - download [2] Wang, Eric Min-yang, and Wei-Ching Chao. “Image of Common Measurements Taken on the Face.” In Searching for Constant Body Ratio Benchmarks, Volume 40, Issue 1, Pages 59-67, Science Direct, Jan. 2010, https://www.sciencedirect.com/science/article/abs/pii/S0169814109001048. Accessed 5 Oct. 2021, Google Scholar.

Oct. 10, Silicone 3D Printing Process

THOMAS KRIEWALDT - Oct 10, 2021, 4:08 PM CDT

Title: 3D Printing with silicone

Date: 10/10/21

Content by: Thomas Kriewaldt

Present: N/A

Goals: To develop a better understanding of the materials we will be using in this project.

Sources:

[1] “Is 3D Printing with Silicone Possible?” Beamler - Additive Manufacturing, ACEO, 24 Apr. 2021, https://www.beamler.com/is-3d-printing-with-silicone-possible/.

[2] “A Beginner's Guide to Silicone 3D Printing.” A Beginner’s Guide to Silicone 3D Printing, AMFG, 11 Apr. 2018, https://amfg.ai/2018/04/11/a-beginners-guide-to-silicone-3d-printing/, *Google Scholar*.

Content:

This article details the process of printing with silicone, something that wasn't possible just a few years ago. We are able to create a 3D model using solidworks or AutoCAD and upload it to the website as an .stl file and get it printed through ACEO's website.

The reason why silicone printing is not a common process is because it is such a new technology that it hasn't been widely implemented. SIlicone has a very strange property in that it isn't as susceptible to state changes at high temperatures [1]. This is important because this is how plastics are 3D printed, so it's good to know we can't use the same process for our silicone material. This new method, which was laid out by ACEO according to Beamler, drops tiny amounts of silicon onto the 3D printing tray, and then shines a UV light to harden the silicone structure. Then, the next layer of silicone can be dotted on top of previous layer, and so on, until we get a solid structure of silicone. This will allow it to first form into the dimensions we choose then solidify into a material that is heat resistant, but also flexible.

Again, silicone is highly resistant to hot and humid conditions, which would come into play in our mask's environment. Silicone material is resistant up to 170°F, which is well above any heat that will be given off while the mask is in use [1].

A second article I found details the cost of a typical small part for 3D printing. It states that a small, transparent silicone tube, used in respirators was fabricated at about $19/part [2]. Assuming this tube is a little bit smaller than the mask we plan to fabricate, we should be able to print this below our budget using this source.

Conclusions/action items:

This process seems like it would be the most effective fabrication method for our silicone material, but we should be weary of the cost it takes to print and ship the material to us. Our budget is around $400, and we need to spend some money on the clips and straps of the mask, so the maximum amount we can spend on this print process would be $300. Given the second source cited above, we can estimate this to be just under our budget for a functional silicone print of our design, but we still don't know for certain.

We should contact this company to get an estimate to see how much time and money this will take to create.

Oct. 28, PLA Material Research

THOMAS KRIEWALDT - Oct 28, 2021, 4:19 PM CDT

Title: Effects of Build Orientations on Tensile Properties of PLA Material

Date: 10/28/21

Content by: Thomas Kriewaldt

Present: N/A

Goals: To develop a better understanding of how strong PLA plastic is to envision the maximum forces our printed pieces will have to withhold.

Sources:

[1] Afrose, Faujiya, et al. Effects of Build Orientations on Tensile Properties of PLA Material Processed by FDM. Trans Tech Publications Ltd, 8 Aug. 2014, https://www-scientific-net.ezproxy.library.wisc.edu/AMR.1044-1045.31.pdf.

Content:

This article details a few different methods of plastic printing. It uses the same materials between prints, with the independent variable being the way it is printed. The first trial had the standard printed part oriented with the X-axis, the second was oriented in the Y-axis, and the third was oriented 45° in the X and the Y axis.

These pieces printed in different orientations were then tested on a force machine which exerted up to 10 kN of force. The study found that the X-axis printed piece was able to withhold more force than the 45° or Y-axis printed pieces [1].

Table 1- Tensile Properties of PLA specimens

Build Direction	Tensile strength (MPa)	Tensile Elongation (%)	Tensile Modulus (MPa)
X	38.65	4.14	1538
Y	31.43	4.53	1246
45°	33.63	4.45	1350

This was a significant margin, but not that you can't still print in the Y-axis direction. This is important for our project because we want our model to be as strong as possible to reduce shifting/breaking of the material which could damage the user's glasses in some capacity.

Also, note that the resultant strength of this 3D printed piece was only around 60-64% the capability of pure PLA plastic. This is important when considering future max load calculations in our printed piece caused by forces acting upon it during testing.

Conclusions/action items:

Actually, build and create this model for our project, and ensure that it is oriented on the x-axis to maximize the strength of the piece.

Sept. 15, VM Pro Product Manual

THOMAS KRIEWALDT - Oct 18, 2021, 9:07 PM CDT

Title: VO2 Master Pro, Product Manual by VO2 Master Health Sensors Inc

Date: 9/15/21

Content by: Tommy Kriewaldt

Present: N/A

Goals: To develop a better understand of the components that make up a typical VO2 mask, and also to have an idea of how they are assembled.

Citation:

[1] VM Pro Product Manual, VO2 Master Health Sensors Inc., 22 Feb. 2021, vo2master.com/wp-content/uploads/2020/02/Manual20200209.pdf, *Google Scholar*

Content:

This design follows FCC guidelines, something I failed to consider in our designs before.

- It states: *"This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation." [pg. 5, 1]*

This mask is made of a **bunch** of parts. The main components include:

- Hans Rudolph face mask. This acts as the general face mask to connect straps, tubes, filters etc.
- A single use filter. To prevent toxic buildup of debris, as well as moisture.
- Detachable straps. Two pairs of straps wrap around the head and connect to each other and the mask to ensure a secure fit.
- Ventilation user pieces. Three pieces allow a specific ventilation range to flow into the mask. Three pieces range on athletic ability.
- Locking Nut. Secures the ventilation pieces into the center of the mask.
- VM Pro. Custom, patented component which allows air to flow in and out of the mask. Also runs various VO2 tests based on the inflow of air.
    - This is the component that we will not be replicating (obviously, as it is patented), but replacing with tubes which carry the flow of air to a seperate machine to record various VO2 measurements. We will have to get creative with our attachment to the mask.

Also, this product has clear and specific outlines on how to detach and clean the mask to ensure that the mask is clean and that any VO2 test will not be affected by any debris located on the mask or its components during the test. We should make sure all of our design components are detachable so that we don't run into this general problem.

Conclusions/action items: After seeing this design, we are now able to get a grasp on how a typical VO2 mask is constructed, so we can follow similar methods of assembly with our own design, and eventually product. Also, we must take into consideration the FDA and FCC rules and guidelines when we being to fabricate our design. Lastly, we should take disassembly into consideration, specifically for cleaning purposes at a commercial level.

11/27/21 - Sanding and Design Pictures

THOMAS KRIEWALDT - Dec 02, 2021, 9:51 PM CST

Title: Sanding and Design Ideas

Date: 11/27/21

Content by: Thomas Kriewaldt

Present: N/A

Goals: To sand the team's 3D printed pieces and test the attachment to the mask.

Content:

The team printed out PLA clips that attach to the mask, and stuck them into 1/4" wide holes drilled into the soft plastic clip the team printed.

- The reason why 1/4" worked well was because of the stretchiness of the clip piece. 1/4" is only about 6.3 mm, but our plastic piece had a bottom diameter of 7.5 mm. This slight difference in measurement ensured a snug fit, which could not come loose when it was in use.

Then I put on glasses to test how well the fit was, and how we needed to adjust it going forward. Unfortunately though, the clip was made for the bigger of the two masks that Johnson Health Tech gave us, but I was in possession of the small one. Therefore conclusions on the fit on the small mask could not be made. We should try it out on the larger mask and make adjustments from there.

Conclusions/action items:

While the design was mostly successful, I did not have the correct mask to test it on and properly evaluate how well it works. I need to get the large mask from Jakob, then make observations on the clips on the larger mask.

THOMAS KRIEWALDT - Dec 02, 2021, 10:15 PM CST

IMG_3005.JPG(2.1 MB) - download Picture of the initial print pieces in the hole drilled on the resin clips

11/29/21 - Observations on Initial Design

THOMAS KRIEWALDT - Dec 02, 2021, 10:41 PM CST

Title: Observations on the Large Mask

Date: 11/29/21

Content by: Thomas Kriewaldt

Present: N/A

Goals: To detail my initial observations on the 3D printed supports on the large-sized mask, and make adjustments to our design based off of them.

Content:

Pictured below is me wearing the large mask with our clip and plastic printed supports. The first thing I noticed when I was wearing the mask with glasses was that the plastic pieces were slightly blocking my lower vision. I think that a small adjustment to the dimensions of the piece will fix this issue. Also, the clips were a bit far from the legs of the glasses I was wearing. This should also be fixed in our next print. Lastly, I noticed that the bottom of the plastic pieces were slightly poking into the outer shell of the mask. This again, should not be too big of an issue, and won't impact any results, as the depth of this piece is VERY small, and the edges have been sanded down to ensure the mask won't be punctured.

With all these things considered, I think a shallower start to the plastic piece would solve the first two issues mentioned above. There is no specific way to tell how much we should cut the pieces, but around 1cm should work. We should then test this piece to make sure it fits in the 1/4" hole and attaches to the legs of the user's glasses. Adrienne said that she would be willing to model this new part, so we will test it after then.

Conclusions/action items:

Alter the Solidworks model, then 3D print four pieces and test them on the large mask.

THOMAS KRIEWALDT - Dec 02, 2021, 10:42 PM CST

IMG_3026.JPG(1.3 MB) - download Photo of me wearing the large mask and the plastic printed pieces

12/2/21 - Sanding and Observations on New Design

THOMAS KRIEWALDT - Dec 02, 2021, 11:11 PM CST

Title: Observations on New Plastic Pieces

Date: 12/2/21

Content by: Thomas Kriewaldt

Present: N/A

Goals: To detail observations on the new design of the plastic extension pieces

Content:

The new plastic pieces were printed today. The first thing I did was remove the plastic supports printed with the piece, and sand the result, to ensure no punctures to the mask or the user would take place. Then, I put them into the mask like the previous design to see if they fit, and they did. Shown below is the side-by-side comparison of the old print and the new print and their field of view differences. As you can see, the new piece is only slightly lower than the old piece, but the end of the piece is noticeably closer to the legs of the glasses.

While this new design is only a small improvement over the old one, it is an improvement nonetheless, and might serve as the final one for this design, as it fulfills all criteria set by our client in a sufficient manner. A perfect design may not block any vision of the user, but this is only a small inconvenience, as they were not able to see at all without the clips.

Conclusions/action items:

Attach the velcro straps to the ends of the plastic pieces, and then start to undergo testing! Draw conclusions from the testing and complete all reports and documents.

THOMAS KRIEWALDT - Dec 02, 2021, 11:14 PM CST

66016831964__A7154DB7-BEFB-4488-8445-D325A9FC8C86.JPG(1.8 MB) - download Large mask with new plastic pieces attached

THOMAS KRIEWALDT - Dec 02, 2021, 11:14 PM CST

IMG_3066.JPG(1.6 MB) - download The large mask with both plastic pieces attached to show how each one blocks the field of view of the user

11/3/21 - Testing Outline Brainstorm

THOMAS KRIEWALDT - Nov 04, 2021, 12:12 PM CDT

Title: Testing Brainstorm

Date: 11/3/21

Content by: Tommy Kriewaldt

Present: N/A

Goals: To come up with a rough idea of what we will be testing in our product and steps for each testing method

Content:

I didn't really know where to begin with this testing outline brainstorm for our new product, so I started with our ideas for our old design.

Potential Quantitative Testing:

VO2 Max Testing: Follow the guidelines outlined in the email sent to us by Johnson Health Tech [1].

- Things to keep in mind: We need a big enough sample size to be able to conclude something from the results of testing.
    - Since Johnson Health Tech said one person can test it, one person should try to run a minimum of 10 trials to eliminate bias from low sample size.
    - Low sample size is going to be an issue.. how do we combat this?

Maximum Load Test: Use a stress test machine to see the maximum compressive load our mask piece can handle

- Is this truly useful to this project? Will our plastic piece not hold up to the weight of glasses?
    - Glasses are pretty light, so it might be better to use a functional test on strength while the design is in use. This would save us a little bit of time with a test that we likely don't need to use, and also there is no stress test machine located at the MakerSpace to my knowledge.

Functional Testing:

Comfortability: Follow survey guidelines as outlined below.

- Should have a minimum sample size of 10 people to attempt to eliminate sampling bias.
- Have each subject give a rating of the original mask, then the new clip design on the mask (out of 10).
    - MAKE SURE TO ELIMINATE BIAS FROM THE SURVEY.. think of an effective sentence to begin the survey with..
- Analyze the sample results.. the new mask should be at minimum just as comfortable to wear as the old mask design.

Motion test: During VO2 Mask Testing at Johnson Health Tech, we should observe how much the glasses are moving.

- Should have a minimum sample size of 10 trials to attempt to eliminate sampling bias.
- Glasses should not be able to bounce or move freely while wearing the mask
    - If the glasses are able to freely move in one or more directions, we need to analyze where the moment stems from.
        - If the moment is caused by the velcro attachment, then we need a stronger material or design to hold the glasses in place
- The glasses should not be damaged, scratched, or bent while wearing the mask
    - If this is the case, we need to adjust our design so that glasses can contact a softer surface.
- The plastic clips design should not be noticeably bending or moving in a way that is detrimental to the VO2 max testing, user, or their glasses.
    - If this is the case, we need to adjust the arrangement/design of our clips so that it can support these forces and moments faced while in use

Eyesight Test: The user of this mask should be able to see most things while this mask is in use.

- Note: even a small difference in vision will be an improvement to the original design
- Should have a minimum sample size of 10 people to attempt to eliminate sampling bias.
- Conduct basic eyesight test.. have a user stand 10 feet away from a chart of unspecified design
- Have the user read the chart at the same distance without glasses, with glasses, and with the glasses and the mask on to see how much of the chart they can see
- Analyze these results, draw a conclusion on how much of the visual field is visible while wearing glasses and a mask.

Conclusions/action items: Actually type out separate documents for the tests we will be running on this part.

Sources:

THOMAS KRIEWALDT - Nov 04, 2021, 12:12 PM CDT

Step__Protocol_1_.docx(88.2 KB) - download

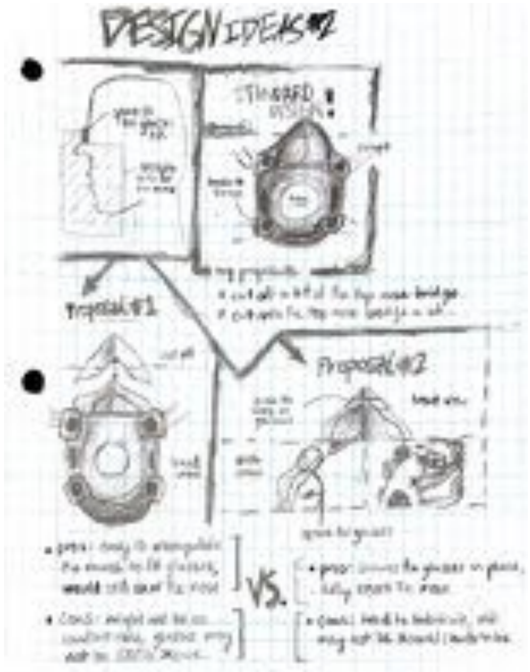
Sep. 13, Preliminary Sketch

THOMAS KRIEWALDT - Sep 16, 2021, 1:14 PM CDT

PreliminarySketch_Sept13.pdf(767.2 KB) - download

Sep. 26, Initial Sketch Ideas

THOMAS KRIEWALDT - Oct 19, 2021, 5:05 PM CDT



Design_Ideas_3.pdf(498.8 KB) - download Here is the second iteration of design sketching. This design is already annotated.

Sep. 29, Personal Notes from Team Meeting (Fabrication of Designs)

THOMAS KRIEWALDT - Oct 19, 2021, 8:12 PM CDT

Title: Personal Notes from Team Meeting

Date: 9/29/21

Content by: Thomas Kriewaldt

Present: All Members

Goals: To combine and select 3-4 design ideas for our upcoming project, based on our initial PDS and Design Matrix.

Content:

Our team met at Union South on September 28, 2021, to discuss our goals above.

We started by discussing some of our own ideas, through sketches, discussion and physical analyzation of a VO2 mask. The three designs we narrowed it down to are shown below in our Design Matrix [1]. Ultimately, after discussing the topic for a while, our team decided on the "Clips and Lower Bridge" design, as it was evaluated the highest of the three designs in our table.

- This design doesn't have a final sketch to go along with it at this point in time, but we have an excellent idea for how we will fabricate it. We want to create a silicon mold to form the base structure for the design, based off of the mask Johnson Health Tech gave us as a reference [2, 3]. We will adjust the design of this mask to move lower on the nose, which will make space for the glasses of the user to fit comfortably and securely. In addition, we will attach small clips to the side of our mask to ensure that the glasses will continue to stay in place, even while in use. This may cover up a portion of the client's visual field, but it is still a large step up from not being able to see at all during VO2 testing. Based on client feedback outlined in our Problem Design Statement [4], we think that this design is most suitable to our client's needs.
- Regarding our Design Matrix criteria, we felt that we ranked and scored each design accurately. Comfort, Accuracy, and Durability were of main concern, due to the client's needs. The "Clips and Lower Bridge" design will allow maximum comfort for users wearing glasses, as before this design, they were unable to, but with this design, they are able to comfortably be able to wear glasses. In addition, we felt that this design should not sacrifice accuracy or durability to meet the needs of user's wearing glasses. The other design criteria we felt was important, but not as the aforementioned ones.

There were a few other potential challenges we considered with this design. The first being the difference in glasses between users. More specifically, adjusting our design for the vast range of sizes, shapes, and dimensions of different frames. We have to plan for all sizes of eyeglasses to fit within our design, so we should make our clips and the height of the silicon on the nose bridge reflect this. In addition, we also discussed materials and the challenges we could potentially face while constructing this design. Personally, I am not nuanced in silicon molding or cutting of silicon, so we agreed to research further into this field to grasp a better understanding before we create any preliminary silicon models. We plan to create a small scale 3D printed model of our design before we move to molding or other fabrication methods.

Conclusions/action items:

Our team decided that the "Clips and Lower Bridge" design, outlined above, is the best for this project moving forward. We should obviously discuss this with our client during our meeting on Friday, to see if they have any suggestions for changes of our design or if they like a different design of ours in our design matrix more for a specific reason. We should then adjust our preliminary outline to fit their feedback.

We also need to research more into our fabrication of this design. Silicon molding and any other techniques we plan to use should be completely understood by the time we get to constructing our preliminary and final model.

Lastly, we need to get started on a small scale model of this idea. We should work as a team to create a SolidWorks or CAD 3D model to help us visualize and adjust our design to fit our clients needs.

Sources:

THOMAS KRIEWALDT - Sep 30, 2021, 1:36 PM CDT

Design_Matrix_VO2_Mask_-_Sheet1.pdf(43.5 KB) - download [1] Team Design Matrix

THOMAS KRIEWALDT - Sep 30, 2021, 1:37 PM CDT

589A7751-2022-4803-A295-7BBAECB7C603.heic(1.3 MB) - download [2] Front picture of the sample mask from Johnson Health Tech

THOMAS KRIEWALDT - Sep 30, 2021, 1:38 PM CDT

9C4CFADE-76DA-459A-BF9F-3A61DAEB59E0.heic(1.8 MB) - download [3] Side view of the sample mask from Johnson Health Tech

THOMAS KRIEWALDT - Sep 30, 2021, 1:53 PM CDT

VO2_Mask_PDS_Version1.pdf(334.3 KB) - download [4] Initial Team Problem Design Statement

Oct. 17, Final Design Sketches on Design Matrix

THOMAS KRIEWALDT - Oct 18, 2021, 9:05 PM CDT

Title: Final Design Sketches

Date: 10/17/21

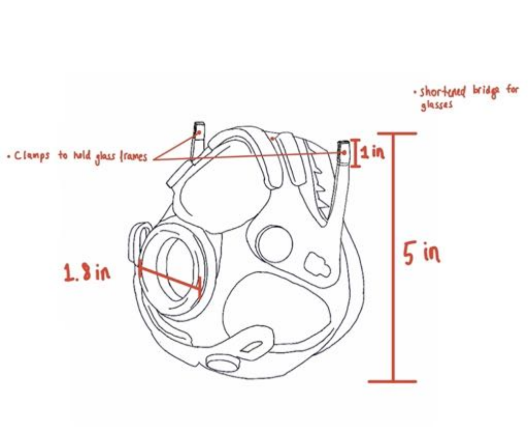
Content by: Thomas Kriewaldt, Sinan Ozturk (et. all)

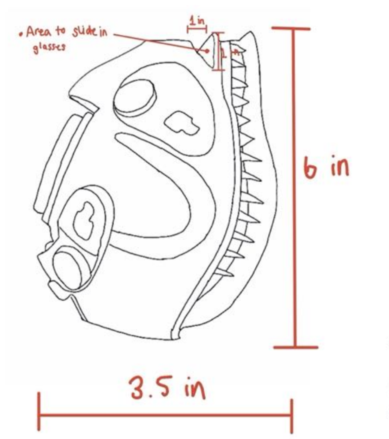
Present: N/A

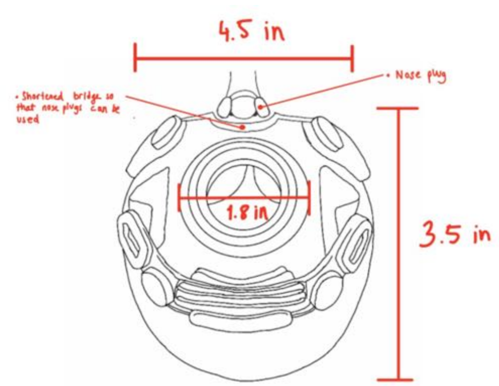
Goals: To compile some of our team's early sketches in one place for later reference.

Content:

These design sketches were planned out together as a team, and sketched out by Sinan Ozturk.



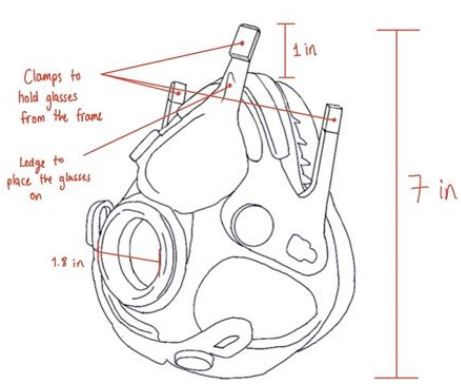




Design 1: Clips and Lower Bridge

Design 2: Divot

Design 3: Nose Clip and Mouthpiece



Final Proposed Design

Conclusions/action items:

Make a more refined AutoCAD or SolidWorks model to fit our design ideas in the pictures above. This way we are able to have more detailed and constrained dimensions/angles moving forward in our project.

Face Measurements 9-25-2021

SINAN OZTURK - Oct 18, 2021, 1:36 PM CDT

Face_Measurements.docx(125.2 KB) - download

Silicon as a material 10-6-2021

SINAN OZTURK - Oct 18, 2021, 2:46 PM CDT

Title: Silicon as a Material

Date/Research From: 10/06/21

Content by: Sinan Ozturk

Present: N/A

Goals: To see if silicon is a material that we can base our design on

Sources:

Cirino, Erica. “Silicone Safety: Risks, Exposure Sources, Is Silicone Toxic & More.” *Healthline*, Healthline Media, 27 Aug. 2019, https://www.healthline.com/health/body-modification/is-silicone-toxic.

Content:

This source elaborates on how silicon could be dangerous to the human body. What I've learned from this source is that, unless silicon is in a liquid state it is almost impossible for it to be toxic to humans. Exposure of liquid silicon can cause illnesses and in some cases may require procedures.

Households materials that are made from silicon are found to be harmless against humans. Silicon is only harmful if it gets inside of your body through ingestion, injection, absorption or leakage from an implant.

Conclusions/action items:

Silicon used on our mask should not be harmful if the mould is executed properly.

Effect of Using Training Mask 9-28-2021

SINAN OZTURK - Oct 18, 2021, 2:48 PM CDT

Title: Silicon as a Material

Date/Research From: 09/28/21

Content by: Sinan Ozturk

Present: N/A

Goals: To further understand the benefits of using a training/VO2 mask

Sources:

Porcari, John P, et al. “Effect of Wearing the Elevation Training Mask on Aerobic Capacity, Lung Function, and Hematological Variables.” *Journal of Sports Science & Medicine*, Uludag University, 23 May 2016, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4879455/.

Content:

According to this report 24 "moderately trained" subjects completed 6 weeks of high intensity training. After the training sessions, tests were done on subjects, one of them being VO2 max training. It was found that there were significant improvements in both mask and control groups amongst subjects.

		Pre	Post	Change (%)
VO_2max (ml·kg·$^{-1}$min^{-1})	Mask	44.8 (6.4)	52.2 (7.5)$^{\#}$	+ 16.5
	Control	43.6 (6.2)	49.5 (7.0)$^{\#}$	+ 13.5
PPO (watts)	Mask	276.1 (61.8)	313.5 (69.4)$^{\#}$	+ 13.6
	Control	282.5 (52.0)	310.4 (56.0)$^{\#}$	+ 9.9
VT (ml/kg/min)	Mask	29.4 (8.1)	33.5 (7.0)$^{\#}$	+ 14.0
	Control	29.1 (3.6)	29.7 (6.9)	+ 2.1
PO at VT (watts)	Mask	162.5 (63.5)	193.8 (51.3)$^{\#}$	+ 19.3
	Control	158.3 (38.9)	172.9 (48.2)	+ 9.2
RCT (ml·kg·$^{-1}$min^{-1})	Mask	39.1 (8.1)	43.1 (7.2)$^{\#}$	+ 10.2*
	Control	39.2 (5.8)	39.6 (6.0)	+ 1.0
PO at RCT (watts)	Mask	243.4 (62.4)	283.3 (75.6)$^{\#}$	+ 16.4*
	Control	262.5 (57.9)	272.9 (52.7)	+ 4.0
Maximal Heart Rate	Mask	187 (10.4)	187 (8.5)	+ 0.0
	Control	186 (10.7)	186 (9.8)	+ 0.0

Conclusions/action items:

After this research it was found that training masks do not stimulate altitude but they work more like a respiratory enhancing device.

Safety Measures 9-27-2021

SINAN OZTURK - Oct 18, 2021, 3:23 PM CDT

Title: Safety Measures For Testing

Date/Research From: 09/28/21

Content by: Sinan Ozturk

Present: N/A

Goals: To learn more about the safety measures of VO2 testing

Sources:

Rowe, Michael F. “Safety Measures for Conducting Exercise Oxygen Consumption, VO2, Tests in Developing Countries - Michael F Rowe, 2020.” *SAGE Journals*, https://journals.sagepub.com/doi/abs/10.1177/0049475520918033.

Content:

Some measures include: "1) Disinfecting reusable plastic masks and rubber tubing with bleach solution

2) Limiting maximum exposure of test individuals to Cl_2 gas to <1–3 ppm for a duration of ≤15 min to prevent respiratory distress

3) Carefully inspecting for degradation of plastic VO_2 masks and rubber tubing repeatedly disinfected with bleach and replace these at the first signs of deterioration."

Competing Mask Designs 9-23-2021

SINAN OZTURK - Oct 18, 2021, 2:12 PM CDT

Title: Competing Mask Designs for VO2 Max Masks

Date: 9/23/2021

Content by: Sinan Ozturk

Present: N/A

Goals: Compare the qualities of competing VO2 Max Masks

Content:

<u>VO2 Master Pro</u>

- Mobile application that allows easy access to data

- Wide range of data available to improve training/exercising standards

- Whole set cost: $4999

<u>CardioCoach</u>

- "Simple and accurate VO2 Testing"

- O2 Sensor Accuracy = ±0.2% O_2

- Air flow sensor accuracy = ±2% of reading

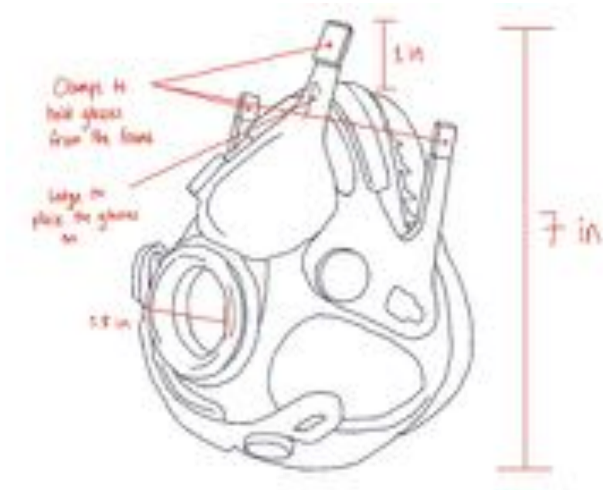
Preliminary Design 10-30-21

SINAN OZTURK - Sep 30, 2021, 11:29 AM CDT

IMG_168A7281D9DD-1.jpeg(593.3 KB) - download

Final Design 10-18-2021

SINAN OZTURK - Oct 18, 2021, 1:13 PM CDT



IMG_1848.jpg(446.2 KB) - download

Blue Permit

SINAN OZTURK - Oct 18, 2021, 1:24 PM CDT

Screen_Shot_2021-02-11_at_14.39.22.png(1013.4 KB) - download

2014/11/03-Entry guidelines

John Puccinelli - Sep 05, 2016, 1:18 PM CDT

Use this as a guide for every entry

- Every text entry of your notebook should have the **bold titles** below.
- Every page/entry should be **named starting with the date** of the entry's first creation/activity, subsequent material from future dates can be added later.

You can create a copy of the blank template by first opening the desired folder, clicking on "New", selecting "Copy Existing Page...", and then select "2014/11/03-Template")

Title: Descriptive title (i.e. Client Meeting)

Date: 9/5/2016

Content by: The one person who wrote the content

Present: Names of those present if more than just you (not necessary for individual work)

Goals: Establish clear goals for all text entries (meetings, individual work, etc.).

Content:

Contains clear and organized notes (also includes any references used)

Conclusions/action items:

Recap only the most significant findings and/or action items resulting from the entry.

2014/11/03-Template

John Puccinelli - Nov 03, 2014, 3:20 PM CST

Title:

Date:

Content by:

Present:

Goals:

Content:

Conclusions/action items: