**GNG2101 Project Deliverable C**

**Universal Mask Fitting**

Functional decomposition, brainstorming and decision matrices

Submitted by

GNG 2101-D01, D2

Kristen Janzen, 300107082

Kelly Shigeishi, 300130179

Shaun Ruddy 300018735

Yi Shi 300116571

Date: 01/30/2021

University of Ottawa

**Abstract**

The objective of this report is to outline the conceptual process of the decision-making process for the problem presented to us by our client Mark Temnpleton. The problem outlined a need for a mask securing mechanism to limit the development of fog or condensation on the general public's glasses while they wore masks. In the previous project deliverable, our clients' needs were outlined as well as some benchmarking for the final product. In this deliverable research and brainstorming was conducted to produce as many viable solutions to the client's problem as possible. The solutions were then cross reference with the client’s needs in a decision matrix to determine the most effective one. Four practical solutions were selected for additional research and will be outlined further on in this report. Out of the four solutions two were chosen as exceptional possibilities. These two solutions are the *Magnetic attachment solution* and the *silicon aluminum nose piece solution.* Prototypes will be constructed of the two solutions and as well as a prototype of a combination of the two solutions. In the next couple of weeks, the prototypes will be analyzed, perfected, and then presented to the client.

**Table of Contents**

**Abstract ii**

**Table of contents iii**

**List of Figures iv**

**List of tables v**

1. **Introduction** **1**
2. **Functional Decomposition 2**
3. **Ideas Generated 3**
4. **Decision Matrix 6**
   1. **Best concepts and sketches 7**
      1. **Goggles Enclosure 7**
      2. **Magnetic Paint 7**
      3. **Magnetic Attachment 8**
      4. **Silicon Aluminum Nose Piece 9**
5. **Feasibility Study and Design Selections 10**
6. **Conclusion 12**

**List of Figures**

**Figure 1:** Functional Decomposition **2**

**Figure 2:** Example of the Tightening System on a Common Snowboard Boot **4**

**Figure 3:** Sketch of Goggle Enclosure design **7**

**Figure 4:** Sketch of Magnetic Paint Design **8**

**Figure 5:** Application Process Diagram of Magnetic Attachment Solution **9**

**Figure 6:** Silicone Aluminum Mold and Stick Nose Piece Sketch **10**

**Figure 7:** Combining the Silicon Aluminum and Magnetic Attachment Concepts **11**

**List of Tables**

**Table 1**: Decision Matric and Idea Ranking **6**

1. **Introduction**

In the prior report the client needs and wants, a problem statement, a set of metrics and target specifications were generated in order to be able to best satisfy the client's needs while creating the product. This report has a focus on using the out lined needs (increased visibility for people wearing masks and glasses, comfort, affordability, washability, ease of use and compatibility with all masks and face types), the metrics (defined in the decision matrix) and target specifications to come up with a concept or multiple concepts that would satisfy the problem statement (To create a product to reduce moisture inside glasses and increase peoples’ visibility and improve the overall fit of a cloth or paper mask.)

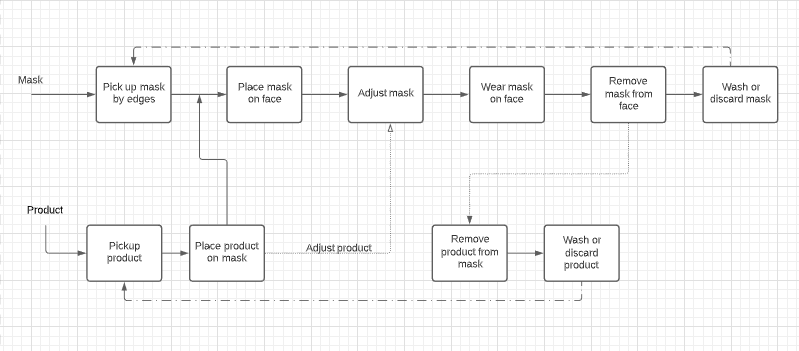
The product being designed has the goal of increasing the visibility of the user while wearing a mask, the low visibility is due to accumulated condensation on glasses, which makes navigating the pandemic situation difficult for glasses wearers. In order to best solve the problem and satisfy the client’s needs, a variety of solutions have been created.

First a functional decomposition was created to determine the main function and break down the required task that the final solutions would have to perform. Using this a total of 12 practical solutions were generated. Following the brainstorming meeting a decision matrix was created to determine the four best solutions, the best were solutions then further explored and sketched. Finally, the best solution can be determined by comparison and completing a feasibility study.

1. **Functional Decomposition**

A functional decomposition is used to break down the operations that will be required by the product. Breaking down the main function into smaller more manageable steps and sub-functions helps to determine the elements required to create the product.

The main function of the product is to prevent the fogging of user's glasses when they wear a mask. For the functional decomposition, all the functions in the process of wearing a mask and the product were included.



**Figure 1:** Functional Decomposition

The functional decomposition contained two different streams or sub systems. One for the mask and one for the product itself. After the steps of applying the product to the mask the streams combine into one as the mask and the product are used together. They are then separated again once the use of the product is completed, and it is removed from the mask and wither washed or disposed of.

Creating a functional decomposition allowed for the steps of the use of the product and functions needed to be defined and assisted in the generation of ideas and concepts for the products design in order to be able to perform these functions and meet the design criteria.

1. **Ideas Generated**

Many ideas were generated to solve the problem presented to us. As our objective consists of increasing visibility of mask wearing customers who struggle with an accumulation of condensation forming on their glasses, solutions varied from attempting to seal exit points of the mask, redirecting the flow of air or even creating a controlled breathing environment. A total of 12 possible solutions were generated: goggle enclosure solution, modified nose clip solution, magnetic paint solution, magnetic attachment solution, silicon aluminum nose piece solution, heat shrink solution, moisture absorption solution, snowboard tightening solution, vacuum filtration solution, tracheostomy. A description of every conceptual idea will now be described in the following paragraphs.

The *Goggle Enclosure solution* consists of use a hollow silicone sealing ring cling to the face to prevent moist gas from escaping. The structure of the silicone ring is like that of the sealing ring of swimming glasses.

The *Sticky Silicone solution* consists of using an aluminum strip to mold the apparatus to the shape of the users nose and cheek bones. The silicone would then act as an adhesive to prevent the moisture from inside the mask from escaping. Due to this protective barrier the glasses would not be fogged.

The *Modified Nose Clip solution* consists of a small plastic piece that can easily be place over the top of the mask at the nose location. The shape of the piece presses down on gaps at the top of the mask.

The *Heat Shrink solution* consists of encapsulating the mask with a heat shrink like material which when heated would form fit to the consumers face. In theory this would close all gaps of the mask and ensure maximal mask effective.

The *Moisture Absorption solution* consists of a material being attached to the top part of the mask where it sits on the nose of the user. The material will absorb the moisture caused by the user’s breath, which in turn limits the condensation on glasses. This could be made from sponge, cloth or another absorbent material.

The *Snowboard tightening solution* consists of creating a large attachment around the mask of the consumer. This attachment would have a structure and multiple wires flowing over the mask in locations where common gaps occur. Similar to new snowboard boot designs a rotational tightening mechanism would be installed on the side of the face. Users could then twist the tightening mechanism to close of unwanted gaps in the mask.



**Figure 2**: Example of the Tightening System on a Common Snowboard Boot

The *Magnetic Paint solution* consists of a tube of liquid that contains iron oxide with an applicator and a separate piece that is lined with magnets and attached to the top of the mask. The “paint” is applied to the face where the mask is to sit. The second piece is folded over the top of the mask and adheres to the faces where the paint has been applied.

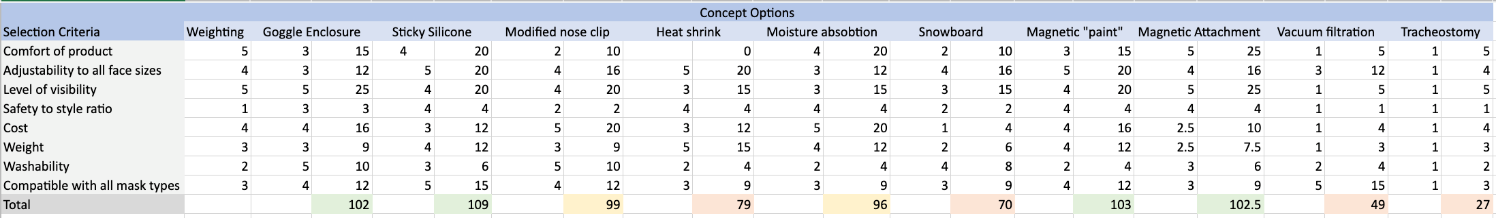
The *Magnetic Attachment solution* consists of using a magnetic strip to securely attach the mask of the consumer to their face. Two magnetic strips will be used and will sandwich the consumers mask to their face. The first strip will be attached to a form fitting material placed over the nose of the individual. The mask will then be placed over the nose and the first strip. Finally, the second magnetic strip will be placed over the mask to enclose all gaps. This solution could potentially remove the need of ear straps around the mask.

The *Vacuum Filtration solution* consists of using two different compartments on the ends of mask to create a vacuum by having a rapid change in temperature (cooling fluid required) resulting in a change in pressure and the moisture being sucked out from the inside of the mask before it could fog up the user’s glasses.

The *Tracheostomy solution* consists of preforming a surgical operation on the consumer. This solution does stop individuals' glasses fogging up due to condensation but is very invasive. It is obviously not an ideal solution and will be disregarded in this aspect.

1. **Decision Matrix**

The decision matrix is used to help determine the best solution out of the ideas generated during the brainstorming session. This is done by ranking the ideas against a reference and by multiplying by the relative importance of each criteria. The reference product in this case was the solution of simply taping the mask closed as this is what had been previously attempted by the client. From this the metrics defined and the product concepts generated were inputted into a decision matrix:

  
**Table 1:**  Decision Matrix and Idea Ranking

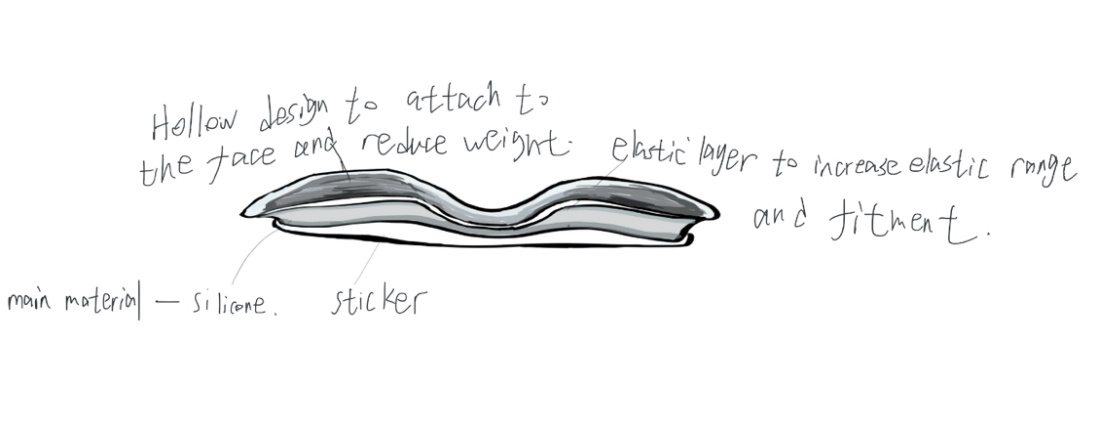
By summing the rankings (on a scale of 1-5) after multiplying the by the weighing factor (importance factor) the total score for each of the different potential products can be calculated. This revealed that the four top solutions to the Universal Mask Fitting Problem were the Sticky Silicon (or aluminum silicon) concept, the Magnetic “paint” concept, the Magnetic Attachment concept, and the Goggle Enclosure concept. In order to select the best concept these solutions were each further explored and studied on feasibility.

* 1. Best Concepts and Sketches

The concepts of the Goggle Enclosure, Silicone Aluminum Nose Piece, Magnetic paint and Magnetic Attachment were further developed and sketched to gain a deeper understanding of the solutions and how they would operate. The development of these ideas had the goal of determining which (or which combination) would be more feasible, be the best fit for the client’s needs and solve the problem statement.

* + 1. Goggles Enclosure

The design concept is based on swimming goggles, which look like an elongated sealing ring of the goggles.

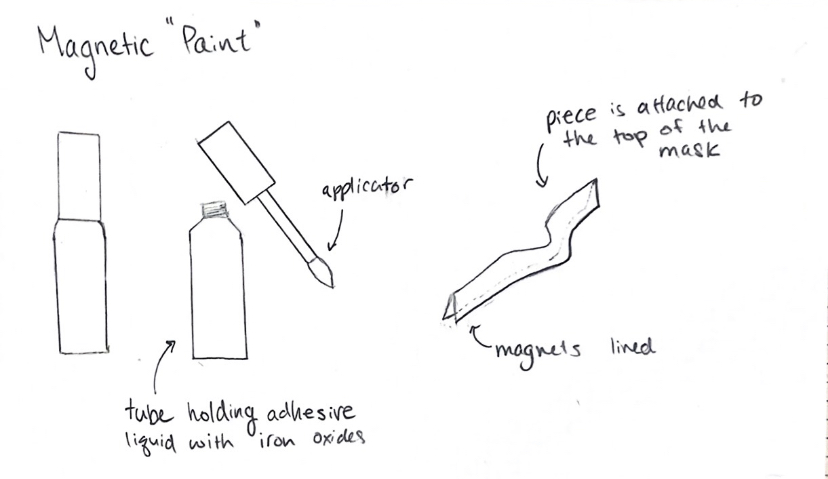


**Figure 3:** Sketch of Goggle Enclosure design

All parts of the product are made of thin silicone except for the bottom, which is used to stick to the mask. The elastic layer in the middle makes the product more comfortable and adaptable. Hollow design makes the product easy to adsorption on the face, better ensure the sealing and have a light weight.

* + 1. Magnetic Paint

This concept consists of two separate components. The first component is the magnetic “paint” which is applied to the face of the user in horizontal line below the eyes like where the top of the mask would sit. The magnetic paint is kept in tube with a twist cap and an applicator attached to the inside of the cap (similar to a tube of mascara). The second component of this design is a rectangular piece that folds over the top of the mask and is lined with magnets. The folded piece adheres to the magnetic paint applied on the face sticking the mask and blocking any airflow in the upwards direction.

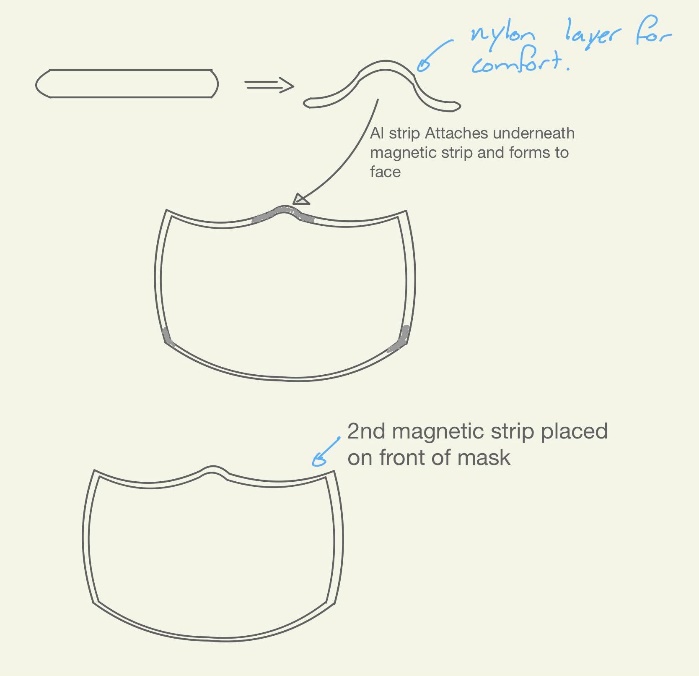


**Figure 4:** Sketch of Magnetic Paint Design

In the decision matrix this design had a total of 103 due to its adaptability to different faces, level of comfort and relatively low weight and cost. A drawback for this idea is having to apply a coat of the solution to your face each time the user wears a mask which could be time consuming.

* + 1. Magnetic Attachment

This design consisted of three main components. Firstly, a strip of magnetic material will be attached to an adjustable aluminum strip. The aluminum strip will be used to form to the shape of the face and/or nose of the user. To make the aluminum strip more comfortable on the face of the user, a comfortable material will be added to one side of the strip.

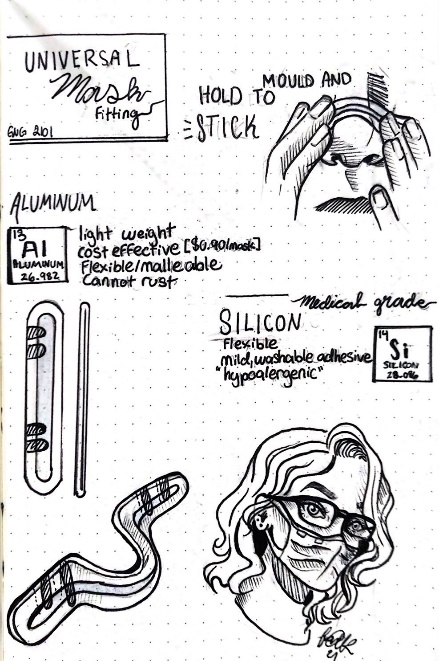


**Figure 5:** Application Process Diagram of Magnetic Attachment Solution

The user will then place their mask over the first magnetic strip. A second strip can then be applied on top of the mask to secure in in place and closing off all unwanted gaps thus limiting the flow of humid air towards users' glasses. This design scored third highest in the decision matrix (102.5) as it presents a possibility of being very form fitting, comfortable and safe.

* + 1. Silicon Aluminum Nose Piece

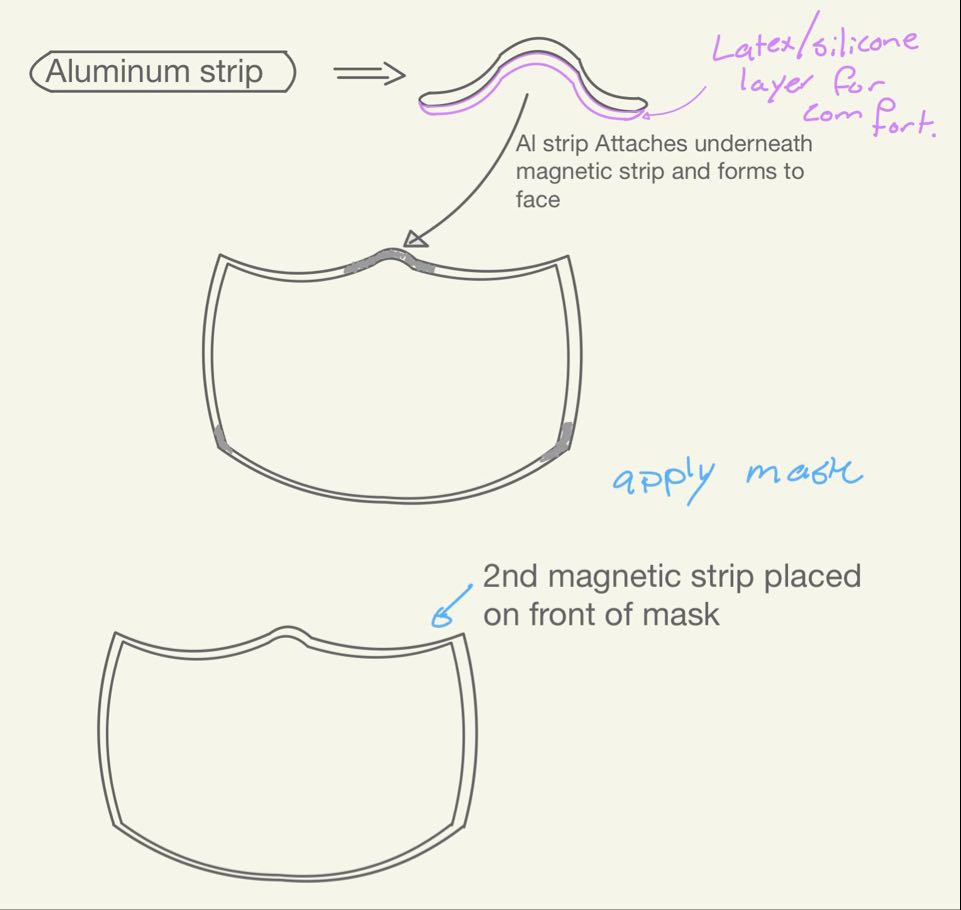
This design was composed of three main parts, the aluminum core, a silicone lining, and aluminum mask attachment clips. The concept of this design was to use the aluminum to help mold the product tightly to the shape of the consumers face. Users would then hold the product firmly to their face (while smiling for better adhesive results) for a couple of seconds to allow the silicone to create an adhesive seal between the product and their face. Finally, the mask would be attached to the product by clamping the aluminum clips closed over the mask to hold it securely in place.

  
**Figure 6:** Silicone Aluminum Mould and Stick Nose Piece Sketch

In the decision matrix this concept scored highest (109), this was due to the fact that the design presented a possibility of being light weight, adjustable to all face sizes and compatible with all mask types.

1. **Feasibility Study and Design Selection**

Out of the solutions considered the most feasible are the magnetic attachment solution and the silicon aluminum nose piece. It was decided that the goggle enclosure concept and the magnetic paint solution were to be discarded as practical solutions. The goggle solution presented a product that would end up being too large, obtrusive, and non-cost effective. It would have also been difficult to complete within the required time frame. Although the magnetic paint solution mildly resembles the magnetic attachment solution it could prove difficult to mass produce. In fact, patents on magnetic liquids already exist and it would prove difficult and tiresome to get legal permission to use the material for our own needs. As the magnetic attachment and the silicone nose piece solutions are feasible to create in our time frame, are cost effective, and efficient, these solutions will be explored. It is also possible to combine the two solutions to create an even more comfortable easy to use and effective solution.



**Figure 7:** Combining the Silicon Aluminum and Magnetic Attachment Concepts

This could be achieved by using the “base” of the Silicon Aluminum method without the mask clips, then this would be attached to the magnetic strip resembling this method from there on out. Though this method may have a larger weight it would provide an overall better fit for the client’s needs and wants by providing a barrier to keep glasses from fogging while wearing a mask in a comfortable and cost-effective way.

1. **Conclusion**

In conclusion, a combination of the silicon aluminum nose piece and the magnetic attachment design were selected as the best option. The functional decomposition highlighted the main function of the product, which was to eliminate the fogging of glasses when wearing a mask. The final chosen combination concept satisfies the tasks and sub-tasks outlined. In the idea generation phase, 12 concepts were produced. During this phase, all ideas were heard and considered without judgment. Taping the mask to the user's face was used as a base reference. The decision matrix was then constructed by comparing all practical solutions to the base reference. The four solutions with the highest scores were then considered and sketched. Next, the feasibility of these four concepts were investigated. It was found that the goggle and magnetic paint concepts were less feasible due to lack of resources available and time constraints. This led to the conclusion stated earlier describing the combination of the silicon aluminum nose piece and the magnetic attachment as the most viable solution.