

Hwa Chong Institution

Project Work

Category 3 Inventions Log Book

Title of Project: Voice Amplifying mask
Group Name: 3-43
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Problem Finding

(The beginning...)

Identify a problem you would like to solve. You may want to brainstorm for problems using different approaches eg thematic, survey or general brainstorming etc.

- 1 A Document a list of problems you have identified. Your documentation should show clearly how your group came up with the problems.**

Problem 1:

Current masks in the market cause negative impacts on speech communication such as muffled voices. Furthermore, masks are opaque and cover the user's mouth. This can reduce one's emotional sensitivity to others as they are unable to read one's facial emotion through their mask. As a result, the muffled voice as well as covered mouth would lead to many preventable arguments if people could hear each other clearer and see their mouths when wearing masks. Clear speech is also needed in other circumstances such as in surgery where a surgeon needs to communicate clearly with the nurses to assist him/her in the surgery. In a classroom setting, teachers also need to have their voice heard clearly but they need to wear a mask to keep the students as well as themselves safe when they are sick.

Problem 2:

It is difficult to count the number of laps and distance ran on running tracks . Due to tracks being too small, GPS watches are ineffective. There is a need for an intuitive and ergonomical ring-like device to help track lap times/number of laps. It is to be put on finger and someone can use it as a stopwatch and recorder for lap number.

Problem 3:

Power banks are inefficient. Although some market solutions provide power banks that are able to stop charging when the device is fully charged, power banks with fully customisable programming that can stop charging after a certain period of time or battery percentage are not available in the market.

1 B You should have selected a problem based on some considerations. Identify and justify these considerations.

The problem regarding surgical masks has been selected due to several considerations.

Firstly, one consideration is whether this is viable. Out of the 3 problems identified, the issue of surgical masks is the most feasible as the other issues require a high-level understanding of electrical engineering and equipment which is lacking in our group.

Another consideration is the need for a solution. With the current COVID-19 situation, many nurses and doctors have to work long shifts wearing a mask and many have complained of the marks left behind on social media. In addition, there is also a shortage of masks within citizens and with the customizable reusable surgical mask, the government would be able to supply enough masks to the citizens while being able to have enough masks for the healthcare sector. The other problems identified however are not needed urgently as there is only a very small market for those who want a ring that can track laps and there is hardly any need for a portable charger that can stop after a certain period of time as the user can unplug the power bank by themselves after a certain period of time.

Lastly, another consideration is whether similar solutions are readily available in the market. For the customizable reusable surgical mask, there is currently no complete solution readily available and similar designs are on design forums such as Thingiverse where people post their design for others to use and not to sell. However, for the lap tracker, there are other lightweight products already available in the market and there is no need for another device that is compacted into a ring. For the power bank issue, there is no need for such a solution urgently as users can manually turn off the power bank and so there is no need for additional smart circuitry or independent integrated circuits to stop the charging.

1 C List some problems your group would like to solve. List also the considerations for selection of problems in the evaluation grid below. Score the considerations, against the

problems, with points 1 (least significant) to 4 (most significant). Sum up the total points for each problem. Identify that problem you would like to solve.

Problem Evaluation Grid

*add more columns and rows where necessary

Considerations for Selection	Problems		
	#1	#2	#3
Feasibility	4	4	3
Need for solution	3	2	2
Originality	3	2	2
Total Score	10	8	7

Define the Problem

(This is one...)

Now that the problem has been identified. It is important to gather information on the extent of the problem and/or evaluate the usefulness of existing solutions based on *some criteria*. You may need to conduct surveys and research on existing solutions.

2 A Extent of problem (Research and discuss the problem and write down the problem statement)

Current surgical masks have several design flaws that reduce its effectiveness and its comfort when worn. For example, these masks are designed to reduce gaps in the mask by wrapping itself tightly around the user's face. This however does not work for certain people as their face shape does not match the mask's design which results in gaps in the mask which will allow contagious viruses to pass through. In addition, due to the tight design, many who wear the masks for long periods of time will have marks on their faces. Furthermore, these masks are designed to be for 1 use and will cause scarcity of masks during virus crises. Therefore, there is a need to design a mask that will be able to be customised based on the user's face shape and yet be reusable and maintainable cheaply.

2 B Compare and contrast the existing or similar solutions.

1. Using N95 masks

- N95 masks are uncomfortable in exchange for being airtight.
- Often, these masks are used by those who are at risk of catching viruses, such as our frontline workers in this current CoVID-19 situation.
- These masks are reusable, but healthcare experts recommend that the mask should not be reused. The US Food and Drug Administration recommends that N95 respirators are shared or reused. The options for reuse of this mask
 1. **Leaving surgical N95 masks to dry for reuse**
 - The inventor of the filtration filter used in the N95 mask, Dr. Peter Tsai, recommends that the N95 mask can be left in the open for 3-4 days to dry before it can be reused. This is a limitation as the long time taken for the mask to dry means that the mask cannot be used everyday and more masks will need to be used. Our product, on the other hand, should be able to dry overnight when the mask is not in use, meaning that the mask can be reused everyday.
 2. **Hanging surgical N95 masks in the oven at 70C for 30 minutes to dry before reuse.**
 - Dr. Peter Tsai presented an alternative option that would allow the mask to dry quicker and allow for daily reuse.
 - However, N95 masks can be degraded by UV light and intense heat and thus this option is not viable as it may damage the mask, rendering the mask useless.

2) Using surgical masks

- Normal non-N95 surgical masks are not airtight, thus they are not very effective at preventing the user from breathing in harmful germs. Thus, in our current situation, they can only be used by the sick to prevent respiratory droplets that carry the virus from escaping into the surroundings.
- On the other hand, our product will be airtight, yet comfortable, so it can be used by all to prevent the spread of the virus, and it will ease the load on doctors who have to wear the uncomfortable N95 mask all day long in situations such as the current pandemic.
- Sometimes, these masks do not have a design that fits the head shapes of certain people. The mask may end up being too tight or too loose for certain people and this will render the mask uncomfortable or too big for effective use.
- In contrast, our product aims to eliminate this problem through the 3D scanning of the face to develop a model that fits the user's face properly

3) Vogmask

- Some might argue that the Vogmask, which is reusable and claims to be a “no-risk, high-reward method to protect respiratory health”, is a perfect replacement to the uncomfortable N95 respirators and the unreliable surgical masks.
- However, testing shows that Vogmasks do not eliminate the threat of illnesses and viruses, and this has been confirmed by the company themselves.
- In reality, Vogmasks use a N99 filter, that is more useful for filtering dust particles, not viruses and bacteria.

- Thus, our product will eliminate this problem as it will use a filter that can keep out the virus.

4) N95 Valve Mask

- Allows users to breathe in through a N95 filter valve, filtering viral and smog particles out.
- Provides tight fit
- Valve and filter is easily replaceable
- However, it allows air that is breathed out to bypass the N95 filter in an effort to reduce heat and humidity, leading to viral spread. Many countries, including parts of the United States, has banned use of this mask during the pandemic

Your BIG IDEA

(Developing the idea....)

Write down your proposed invention and why you want to do it. State also how you think your proposed invention is better.

3 A Describe your proposed invention.

This product aims to combine the reliability of the N95 mask, the comfort of the normal surgical mask and the reusability of the Vogmask to make a mask that has the benefits of all three different kinds of masks, while eliminating all the problems that come with each mask. We plan to use a 3D sensor to capture an image of an individual's face and combine it with a 3d model of a mask for 3D printing. The mask will consist of 3 layers. The innermost layer can be made with tissue paper or any material that is waterproof while the middle layer can be made out of materials such as microfibre that can filter out the virus. The outermost shell that will hold the other 2 layers will be made from the 3d model produced and will be made from a flexible waterproof material such as elastomeric polyurethane. Two ports will then be connected to the sides of the mask containing the fans and filter as well as the audio system.

3 B Explain the purpose of your proposed invention and the potential benefits to users.

The purpose of this invention is to act as a three-in-one mask that is reliable in safeguarding the user because it is airtight, comfortable, and reusable. This product has multiple benefits. Firstly, it is comfortable, thus people who have to wear the mask for long periods of time, such as frontline workers in our current pandemic, will not feel discomfort as they often do with the N95 mask. Secondly, it is airtight, unlike the common surgical mask, meaning that it is more reliable in keeping harmful viruses and bacteria away from the user.

Thirdly, and arguably most importantly, this mask will prevent shortages in respirators in times of crises such as the current CoVID-19 situation or in times of bad air quality, as it is reusable, and masks will be less likely to run out.

3 C In what ways would your proposed invention be different and/or better than existing solutions, if any?

The current existing solutions are the N95 mask, the common surgical mask, and the Vogmask. In comparison to the N95 mask, our mask will be more comfortable, making it more suitable for longer use. In comparison to the common surgical mask, our mask will be airtight, ensuring that viruses and bacteria do not enter the respiratory system. In comparison to the Vogmask, our product will use a filter that keeps out viruses and bacteria, as opposed to the Vogmask that specialises in keeping out dust particles.

3 D What are some problems you expect in the course of your proposed invention?

1. There may be a lack of space in the mask to put the audio system in without making the mask too bulky
2. Weight of the mask may be too heavy
3. Fans may cause injury to user
4. Condensation on clear plastic film may nullify purpose of the mask

3 E What and when are the major milestones (project timeline) in your invention?

- In February, we started brainstorming about the different problems we could attempt to solve.
- In March, we consolidated our ideas and chose masks as the problem our invention will solve and registered our project.
- In April, we continued researching on the different market solutions and possible materials to be chosen. We also submitted our slides and logbook on 14 April for evaluation.
- After circuit breaker ended in July, we resumed working on our project by making improvements based on the feedback given by the judges.
- By August, we went in depth into researching our product and how to maximise usability of our product. Materials and construction process was consolidated and loose ends in the slides were tied up. We presented our slides on 12 Aug for Final Evaluation

Month	Feb	Mar	Apr	July	Aug
Brainstorming	x				
Project Approval		x			
Research and planning		x	x		x
Evaluation #1			x		
Review based on judges' feedback				x	
Final Evaluation					x
Documentation and report					x
Final review					x

#must be able to be constructed based on current / emerging technologies, must not violate the laws of Science or go against the laws of nature.

Construction or Modelling Process*

(This first... then that...)

You are now onto the fabrication of your prototype/ product. You need to select material and understand how to put them together so that your prototype/ product can perform its function.

4 A Explain how and why the materials were chosen for the prototype/ product of your invention

1. N-95 Filters
 - a. N95 filters provide a very high level of filtration, being the choice of medical professionals. It also enables the mask to be more versatile and useful during hazy seasons.
2. Elastomeric polyurethane (Main Body of the mask)
 - a. This plastic will allow some flexibility in the mask body, allowing the mask to bend to fit the user's face better
3. Padding foam (Lining of the mask in contact with the face)
 - a. Soft material that will allow the mask to be comfortable and prevent marks being left on the user's face.
4. Plastic film
 - a. Transparent plastic film will allow users to convey emotions better by showing mouth.
5. 12v mini fans
 - a. Powerful enough to facilitate the circulation of air inside the mask, but not too powerful that it poses a danger to the users.
 - b. Will use 23A batteries.
6. Acrylonitrile butadiene styrene
 - a. This will be used for the side ports as it is a hard plastic that is able to hold the parts inside the port
7. Mini speaker
8. Mini microphone
9. Audio mono amplifier
10. Adjustable resistor
 - a. To control the volume of the speaker

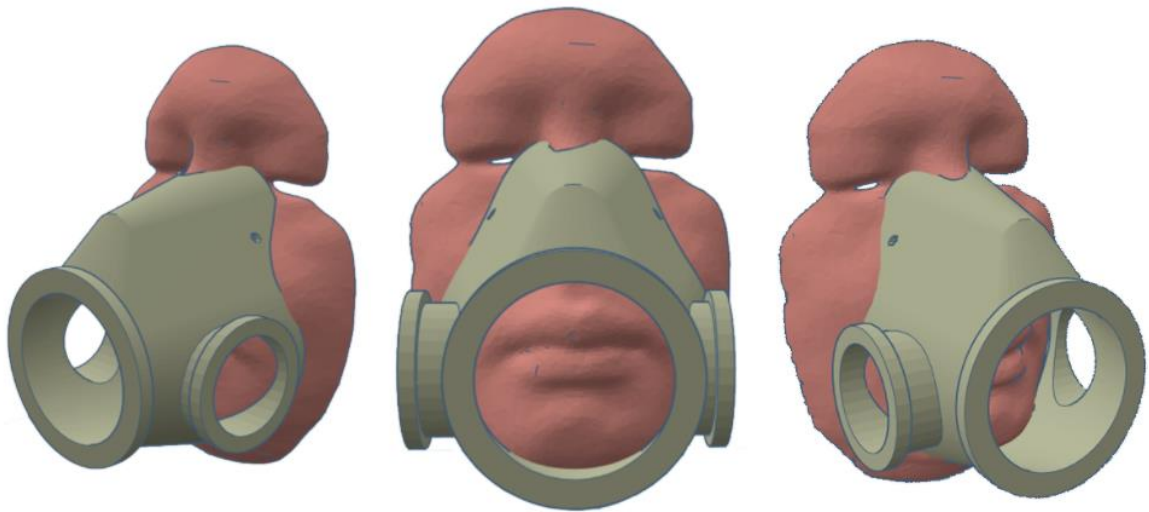
4 B Explore these considerations that may guide the construction of your prototype/ product.

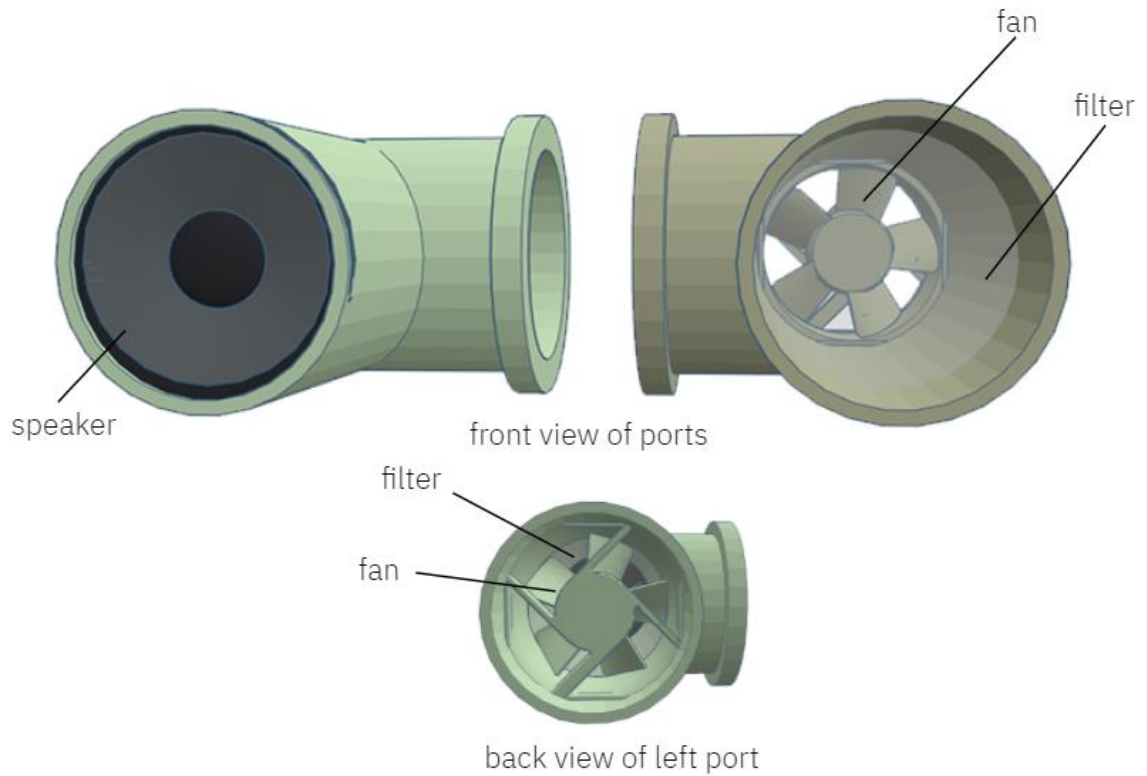
When producing the 3d model of the prototype, scandyplo was used to scan the users face and that scan was then merged with a base design on the mask to produce a 3d design of the mask that is able to fit the user's face perfectly. To ensure that the audio system is sustainable, we

sourced for the least energy consuming products to ensure that the batteries are able to last for an adequate amount of time. After doing research on the batteries needed, we have decided on 23A batteries as these batteries are 12V and yet tiny which allows for less batteries for the same amount of power. In addition, this allows more batteries to be fitted into the mask for the same weight as a normal battery for example a AA battery which is only 1.5V.

4 C Document the prototype/ product development stages. You may use drawings, photographs or videos.

3d model of first prototype





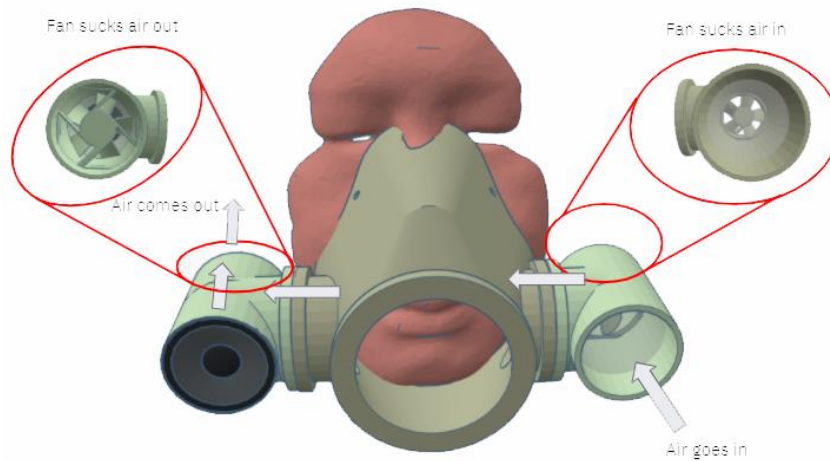
OR

If construction of the prototype is not possible, then you have to create an animation / as a proof of concept that it can be applied in a bigger scale.

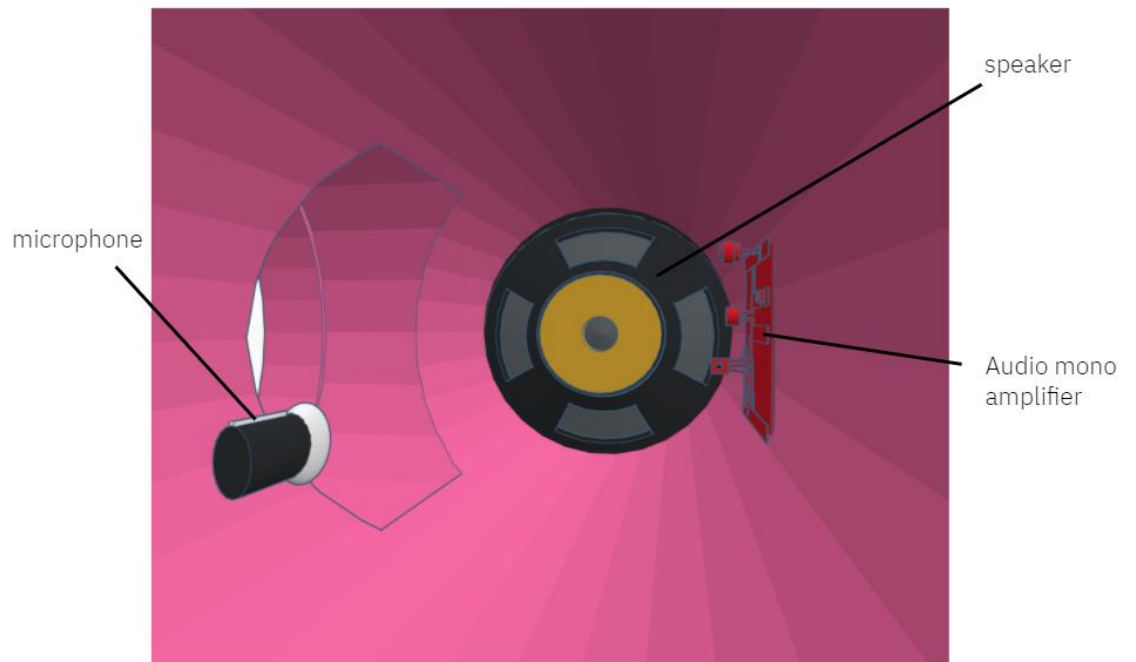
4A Explain why construction of a prototype is not possible and the proof of concept is needed in your case.

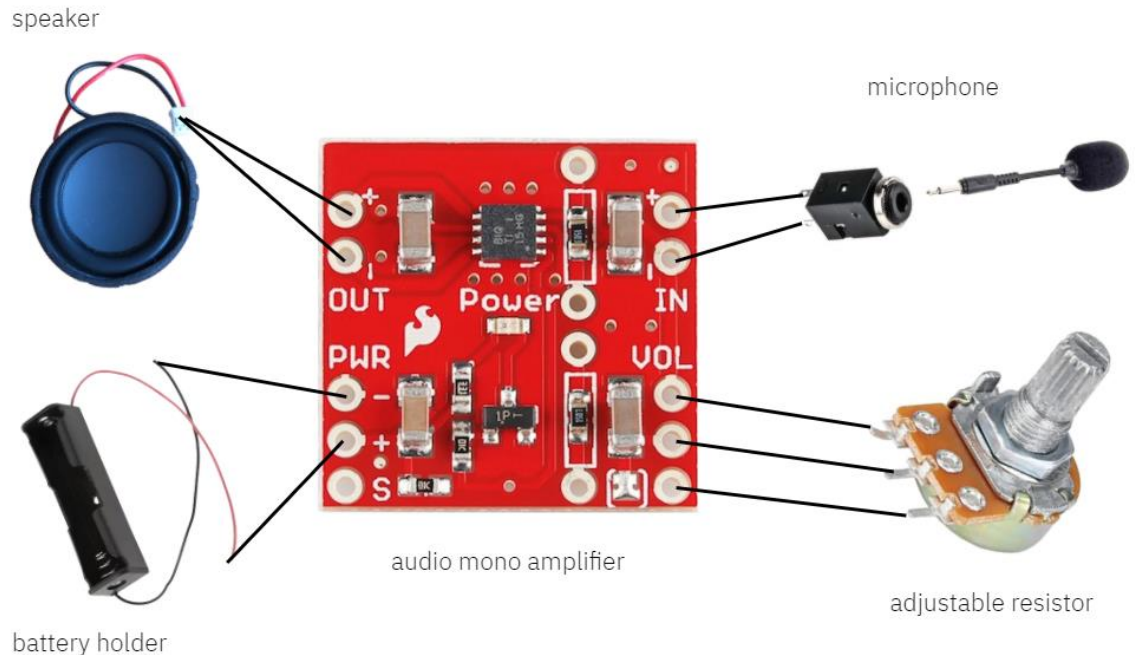
Due to the coronavirus outbreak, most shops are closed, as a result, it was not possible to 3d print the mask body, especially since it required a special flexible plastic.

4B Briefly explain how the video / animation can effectively show how your invention will work and the different considerations.



This photo explains how we plan to resolve issues pertaining to condensation at the front of the mask as well as how air will be circulated. Both ports have a filter to filter the air that passes through. The fan sucking air in will spin at a faster rate than the fan sucking air out. This results in more air being sucked in than the air that can escape, causing the pressure inside the mask to be slightly higher than the surrounding air. This will result in the air trying to escape through the port with the fan sucking air out as well as minimal and tiny gaps along the edge of the mask, preventing unfiltered outside air from entering through any gaps besides the port containing the fan sucking air in.





These 2 images show a rough plan on how the audio system inside the mask will be powered. The first image shows the layout of where the parts will be placed, without the adjustable resistor and battery holder as those will be placed outside the port. The second image shows how the parts will be wired up. The microphone will record the user's voice which is amplified through the audio mono amplifier which will then be played from the speaker. The adjustable resistor allows the user to adjust the volume of the speaker to their liking and the battery holder holds the battery that will power the audio system.

Warning:

*Video / animated simulation only if prototyping is absolutely not possible.
 Video / animated simulation must be logical and convincing that the invention works.
 Constraints must be clearly included in the logbook or the project will be heavily penalized.*

Modification and Evaluation

Upon the completion of your prototype/ product, you would need to see if it is working the way you want it to work. Check if your product has met the identified purpose and the user's need; and implement necessary modifications and improvements. This process may take several rounds.

5 A Write down your prototype/ product test criteria and check against it if it works. Identify areas of weakness for modification. Indicate the test iteration and date of test.

Test Iteration:	Tick			Remarks
Test Date:	Pass	Fail	Potential Failure	

Test Criteria 1				
Test Criteria 2				
Test Criteria 3				

*Add more rows for more criteria

** Repeat table for next test iteration

OR if you are creating an animation / video to show how your invention will work, write down the different possibilities / outcomes (success or failure) if a full-scale prototype is to be constructed.

Possible problems:

1. User’s breathing patterns could be interrupted by the difference in pressure caused by fans.

- This problem was one that we thought of during our design process.
- However, this problem can easily be rectified by ensuring that the input of air from one fan is the same as the output of air of the other fan, thus ensuring that there are no changes in pressure.
- However, given that the fans may be affected by the environment, i.e. the wind and the heat, the input and output of the respective fans may be different from the intended design.
- In that vein, we designed for the mask to use relatively low speed fans in order to prevent any changes in pressure from being too drastic. The lower speeds will not cause the mask to be less effective in providing fresh air, due to the small size of the mask.

2. Users could sustain injuries as a result of fans malfunctioning.

- This concern was raised by one of the evaluators during the Mid-term evaluation.
- In order to prevent any accidents, our group decided to use small and low speed fans to increase safety. In addition, the mask will feature plastic grilles on both sides of the fan in order to prevent any contact with the fan.
- The small size of the mask will ensure that the effectiveness of the mask does not worsen due to smaller and weaker fans.

3. Condensation due to users’ breaths could prevent users’ mouths from being seen, thus eliminating one of the main features of the mask which is to allow the users to convey emotions more effectively.

- This problem was one we thought of during the design process.
- In order to counteract this problem, we implemented an anti-condensation coat on the transparent plastic surface.

References

Read <http://www.bibme.org/citation-guide/apa/> on how to cite references.

6 A Cite the references you have used for your project work. Your source of reference should come from different types (eg books, magazine, websites, journal articles, interview, photographs, product brochure, reviews etc.)

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