
A CLOUD THAT
YOU CAN WEAR
Exploring ways to subvert facial
recognition systems.

A CLOUD THAT YOU CAN WEAR

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DESIGN FOR PROTEST
SPRING 2020/COVID-19

INDUSTRIAL DESIGN
PRATT INSTITUTE

Design for Protest 2020

ACKNOWLEDGEMENTS

I would like to thank my professors Amanda Huynh and Matte Nyberg for their guidance through the early stages of this project. I would like to thank my professor Swati Piparsania for her continued guidance in focusing this project and making it what it is today. All three of these professors have expanded my horizons to what design can do.

CONTENTS

This project spans the entirety of my final year at Pratt Institute. It began in the Design in Context Studio and was completed in the Design for Protest Thesis Studio the following semester. Through this project, I aim to explore the effects of rapidly progressing technology, specifically facial recognition technology on our everyday lives. It has culminated in the creation of three different objects for varying contexts. Through these three objects, I explore how they might affect the idea of protest in each of the different worlds they live in.

Design for Protest 2020

1. AN OBJECT FOR PROTEST

Object making for protest seems like an absurd proposition. Protest is often only thought of as a rally in the streets, groups of people chanting and marching, voicing their need for change directly and physically. The objects that exist in this space are often DIY and highly specific to that protest. For a designer to insert themselves into this context is difficult and often against the spirit of the protest. This is only one way to protest though, and a large part of the thesis studio was devoted to researching other ways in which people protest. What I discovered is that like art, protest can take any form, and it is not the object or the physical space that it occupies that is the most important, but the ideas that are manifested through the action or the object. The effectiveness of these protests is also often dictated by the context in which the protest happens.

Protest can be everything from one person changing their hairstyle to thousands of people marching on the streets. In order for the protest to be successful, meaning that the protester's voice is heard, the protest has to be attention-grabbing and persistent. The scale or number of people involved is irrelevant. This is where I see an opportunity for an object to be incorporated into protest. An object that creates a spectacle, bringing awareness to the protest, as well as lengthening the duration or the frequency of the protest could be very effective.

Reflecto Cube, Eclectic Electric Collective

Absurdity

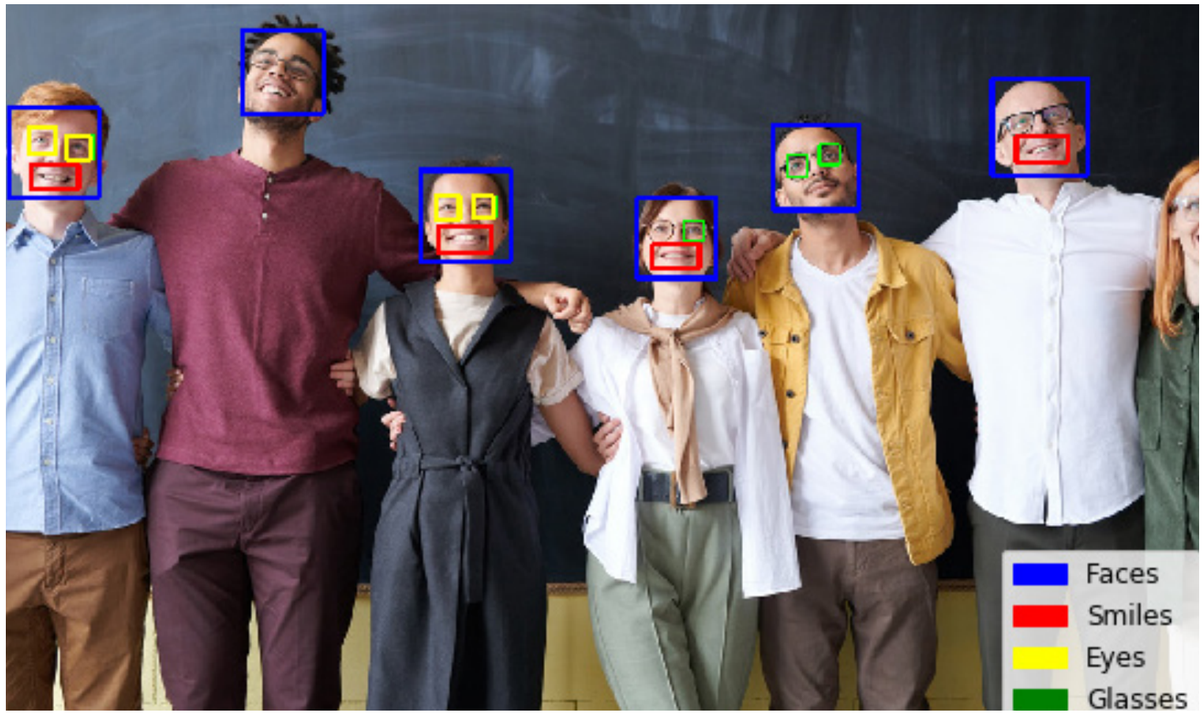
One such object is the Reflecto-cube initiated by Eclectic Electric Collective. The absurdity of having a giant, reflective inflatable cube immediately brought media attention to the protest marches in which it was used. News stations would report on this weird cube at the protests, and would thus also be covering the protests. The cube also changes the environment of the protest itself. It becomes a way for the protesters to interact with each other, bouncing the cube to each other like a giant beach ball. Once the cube gets to the police line it creates another interaction, between the protesters and the police. The police then have a limited number of options, all in the protester's favor. Either they can engage in this game of bouncy cube, becoming part of the protester group, or they can destroy the cube leading to footage of a police officer in full riot gear brutally (but comically) stabbing the cube to death. This idea of creating a spectacle, and allowing other people to interact with it and react to it are really important when creating an object for protest.

Wearables

Another area of protest that interests me is wearables for protest. Something as simple as a t-shirt can become a powerful message. T-shirts are powerful for a number of reasons. Anybody amplifies a message with a t-shirt, all you need is a sharpie, a message and to wear it. The DIY nature allows for anything to immediately become amplified. The t-shirt also allows for infinite scalability if the same t-shirt is worn by many protesters, they create a collective identity of people who believe in their cause. It also allows for the protest to happen in more places than the physical gathering of people.

Someone can protest for their cause on a day to day basis simply by wearing this shirt. Creating something that can persistently amplify a cause regularly in the way that a t-shirt can is essential.

Protest T-Shirt, Decolonize this Place



How Facial Recognition Works

Many of the issues with facial recognition technology are inherent to the technology itself so it is important to have an understanding of the technology before discussing the issues associated with it. Broadly speaking the way a computer recognizes a face is the same way that we recognize faces. When a face is identified in a photo or a camera feed it is then analyzed against all other faces in the system's memory, if the face matches a previous face in the system it is "recognized" In order to match the image to another one that we already know many variables like image resolution, poor lighting, different angles, or any other type of image distortion have to be taken into account. For us doing this in our brains is very easy and we can make this match in fractions of a second with no effort at all. We are able to think abstractly and fill in any gaps with assumptions or our other senses. Computers cannot naturally do this, instead, they have to translate the face they have seen into a string of numbers that it can understand and then compare against all other strings of numbers in its memory to see if any are related closely enough to trigger a match.

We have come up with a number of ways to analyze this data. The first takes any 2D image and breaks it apart into thousands of rectangles subdividing the image many times. The rectangles are then analyzed for their contrast and each is assigned a number of black and white color fills depending on the contrast in the subdivision. This results in a kind of mosaic of black and white rectangles, which correlates with the string of numbers. The second method is the same as how your smartphone recognizes your face. This method uses infrared light and sensors to create a 3D map of a face, matching that back to its memory. Having a 3D image makes it much more reliable because adjustments for lighting and orientation are easier to make. The drawback being that not any camera can be used for this method, unlike 2D facial recognition which only needs a flat image. I will be exploring ways of subverting both of these technologies.

3. THE PROBLEM

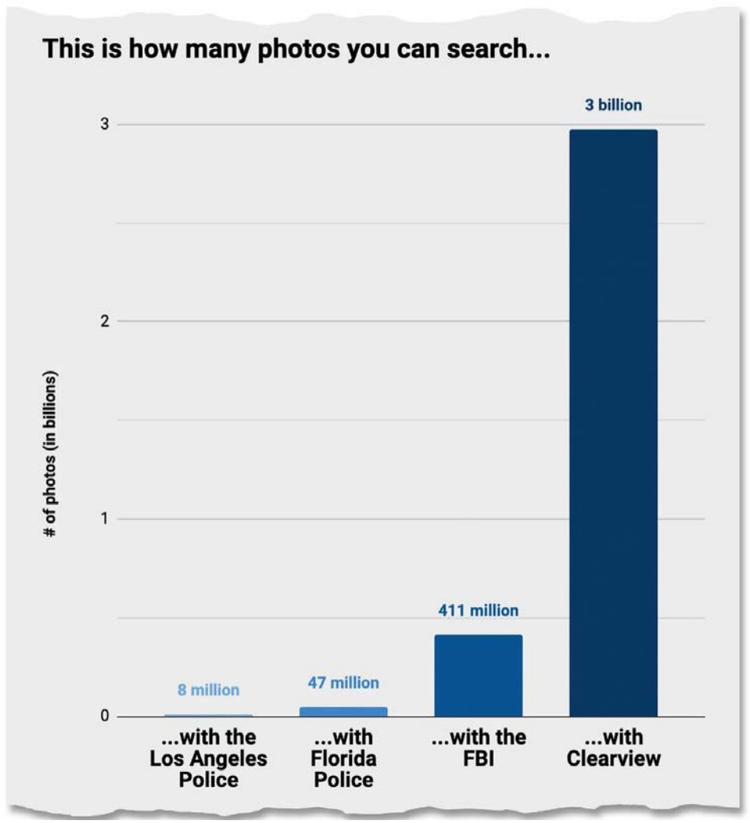
The overarching issue with facial recognition technology is that it takes away our right to our identity and our privacy. Facial recognition systems are already being used in schools, job interviews, supermarkets, and police departments around the world. It can be argued that some of these uses are legitimate and beneficial, but individuals have no way of consenting to this level of surveillance. The technology is unproven and oversight is scarce leaving ample opportunity for exploitation and injustice.

Algorithm Bias

The underlying issue with facial recognition technology is its reliability. The accuracy of the match is only as good as the database that is used to make it and the database often does not represent all of the people it is testing. The computer science world is still very white and very male and most of the databases created to train these systems reflect that. Joy Buolamwini was one of the first people to shed light on this issue through her research at the MIT Media Lab. She found that in three commercially released facial recognition programs the error rate for a white male was 0.8% while that of a black female was 34.7%. The solution isn't as simple as building a larger database either. The current technology also has a maximum amount of images it can analyze before it has too many similar faces. Once the threshold is reached studies have shown that accuracy also degrades. These inaccuracies lead to false positives which can create any number of problems. This technology is already being used by law enforcement and inaccurate results could lead to very harmful consequences.

Questionable Companies

One of the companies selling this technology to law enforcement agencies is Clearview AI. Clearview AI is a technology company recently profiled in the New York Times for its controversial practices. Clearview has sold facial recognition technology to everybody from small police departments in Florida to the FBI. In order to build the database for their app to work on they took information from millions of websites including Facebook and Youtube. Their database now consists of over 3 billion images. Along with access for police Clearview also provided access as a perk for its investors. A select few individuals now have the ability to identify almost anybody on the planet. The app also remains untested by any independent regulators.



Clearview Marketing Data provided by the New York Times

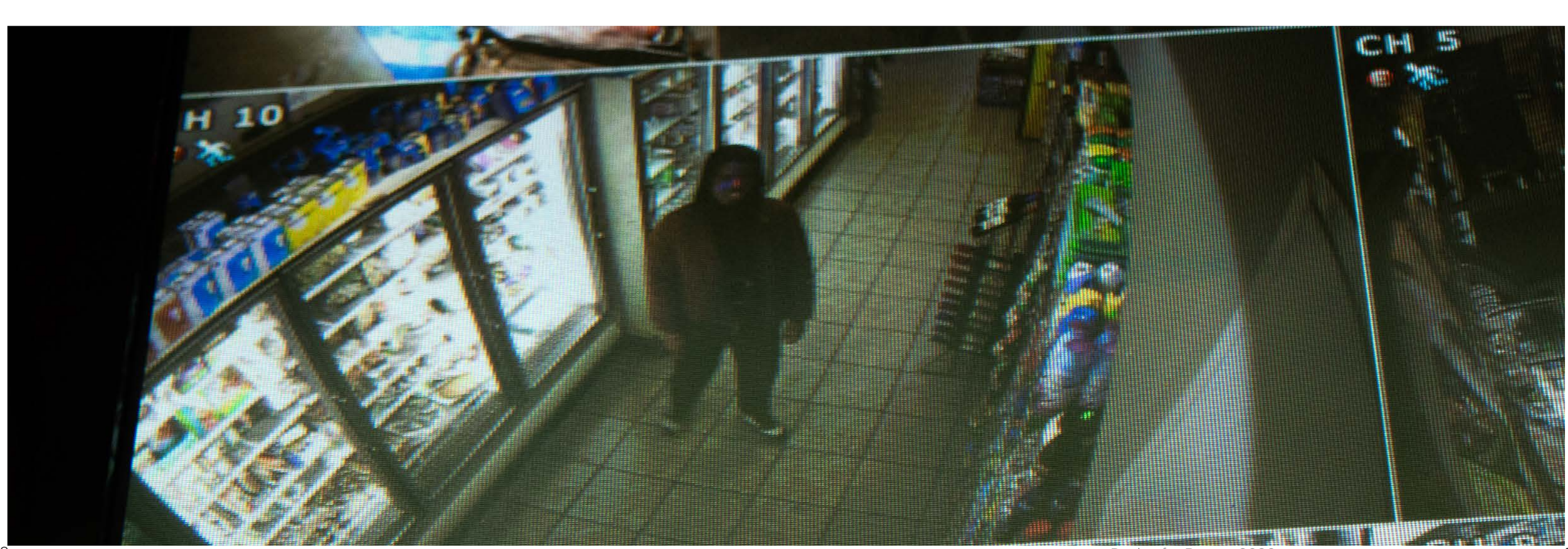

CLOUD JEWELRY


PUFFER VEST


INCOG NITO

4.1 INCOGNITO

Incognito is a sticker pack that makes your face indistinguishable 2D facial recognition. This portion of the project was completed in Fall 2019.



Packaging

Incognito is a sticker pack that makes your face indistinguishable to some forms of facial recognition. They can be applied and removed in seconds and each pattern has been specifically designed and tested against Microsoft's open AI facial recognition engine. The stickers are made from flexible cotton tape that is safe to use on the skin and does not cause discomfort.

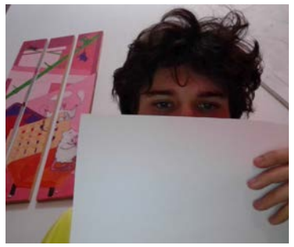
Testing

In order for the patterns to successfully confuse an artificial intelligence algorithm the shapes needed to be irregular to asymmetrically break up the face, and the colors had to be high contrast. I tested a number of methods to attach objects to a face, but I arrived at stickers as the easiest to use and most effective.

To find the patterns that worked I tested them against Microsoft's Open AI system. On the right is an example of a series of these tests. The images on the left (100, 200, 230) are used as controls for the system to test the other images against. The algorithm assigns a percentage for the likelihood that the two faces are related, if the likelihood is under 50% it does not recognize a match. These percentages, or "NM" for no match are recorded below each image. The 100 series of images establishes a baseline to see what portions of the face the system recognizes best. The following images highlight some of the tests that I performed. The remainder of the testing is documented in its entirety in a separate process book and each image can be referenced back using the number assigned to the image.

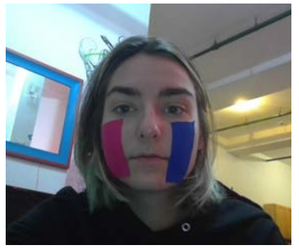
100.
Control

104.
C. 77%



106.
C. NM

200.
Control

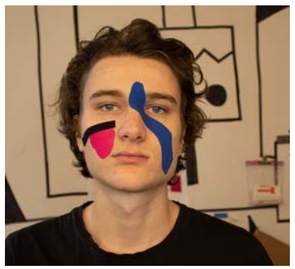


201.
C. 74%

202.
C. NM

230.
Control

231.
C. 81%



232.
C. NM

236.
C. 74%

237.
C. 81%

238.
C. 74%

Daily Wear

Incognito is meant to be worn as daily protection against facial recognition. They leave the face recognizable allowing for normal social interaction while also protecting the wearer. These could be used when going about daily activities like shopping, working, or going to your local deli. The stickers are unusual in the context of normal society so they might prompt questions or engage outside people with the protest, but it is not the main intent of this object. These might even become normalized at some point, like wearing a mask has become now, as this technology becomes more integrated into our society.

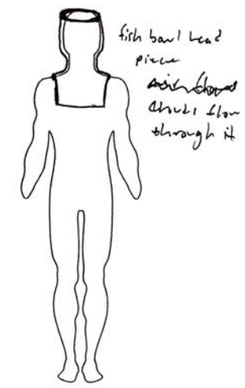
The remainder of this project was done in spring 2020 and during the COVID-19 crisis. The project has had to change drastically in light of the crisis, possibly for the better. The original concept was a wearable cloud, this was supposed to be a fully functional object that could believably protect the wearer from being recognized. What it has become now is a reflection of the things that I am questioning and exploring in design. As a person who is driven by object making, I have never fully had to articulate the ideological basis for the work that I did. Without the possibility to physically make it I became entirely free to explore these ideas that I never fully fleshed out. What I have found is that I really value and enjoy this side of the design process and it has helped me understand who I am and what I value as a designer. The following two objects were designed side by side, they have not been prototyped, but I have designed them so that if they were built they could be as close to fully functional as possible.

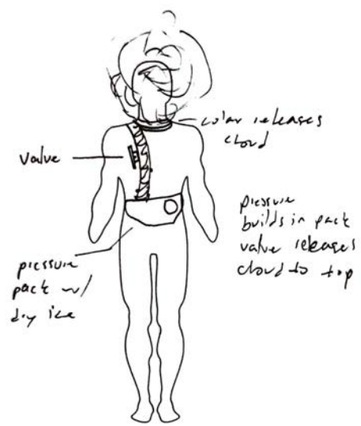
Design for Protest 2020

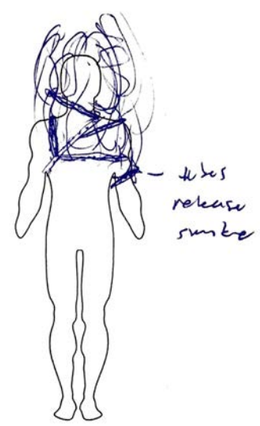
A CLOUD THAT YOU CAN WEAR

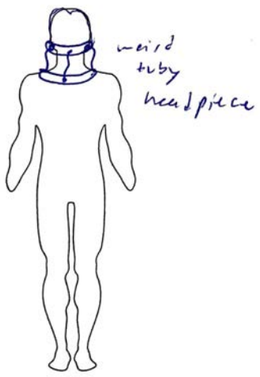
Sketches

The process for both objects began with the following sketches. The idea for the object is that it releases a cloud to obscure the face and block infrared and 3D facial recognition. When the crisis hit I had narrowed these sketches down to three final ideas to pursue and then ultimately choose one to make. I did not end up doing this and instead pursued two different directions that this sketching took me in.



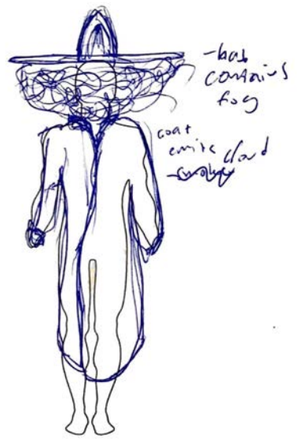




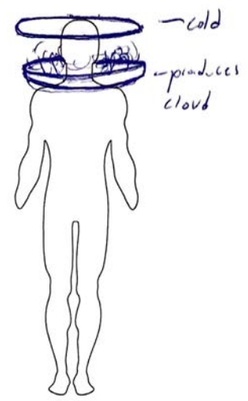

weird
tuby
headpiece

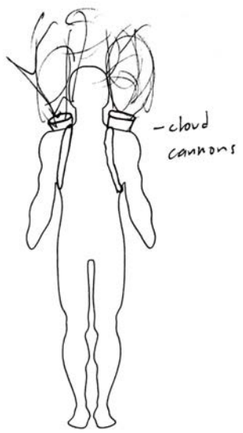

- lots of
inflating
and deflating
packets to
push air
through
system

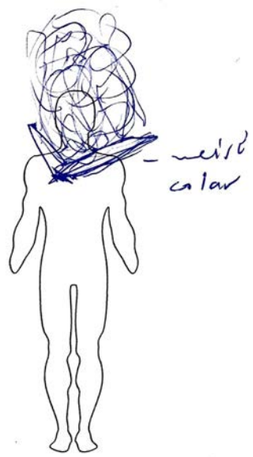

- necklace releases
clouds

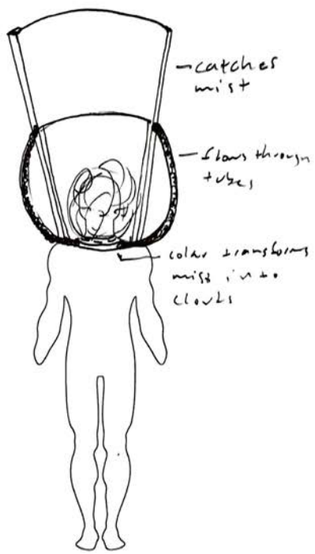

- hat
contains
fog
coat
emits
cloud
- scarf

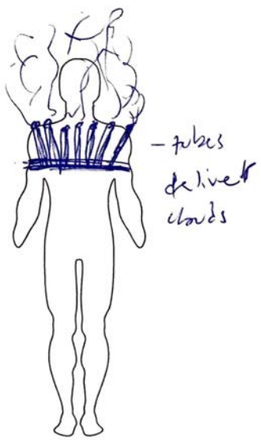

shoes
that
release clouds
as they step

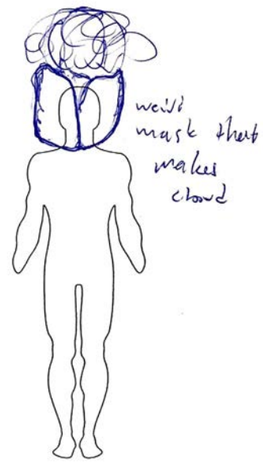

- cold
- produces
cloud

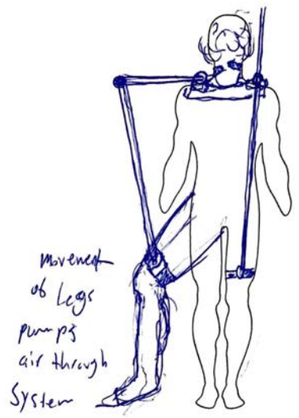

- cloud
cannons


- weird
collar

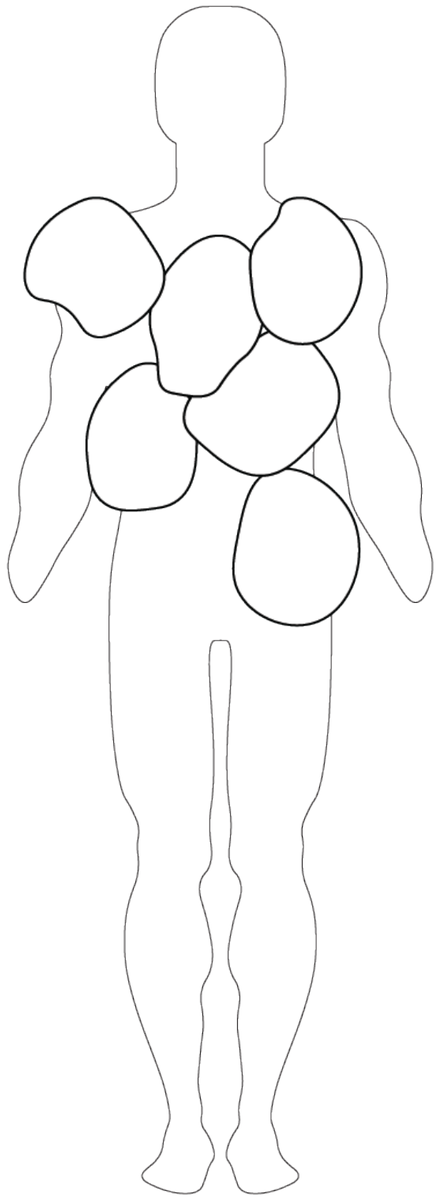

- catches
mist
- flows through
tubes
- collar transforms
mist into
clouds

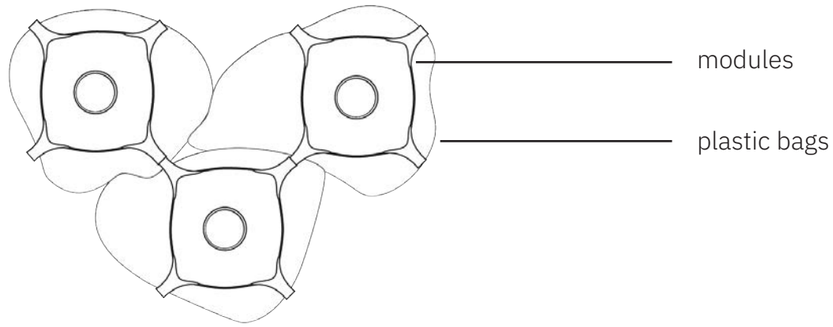

- tubes
deliver
clouds


weird
mask that
makes
cloud


movement
of legs
pumps
air through
system

4.2 PUFFER VEST



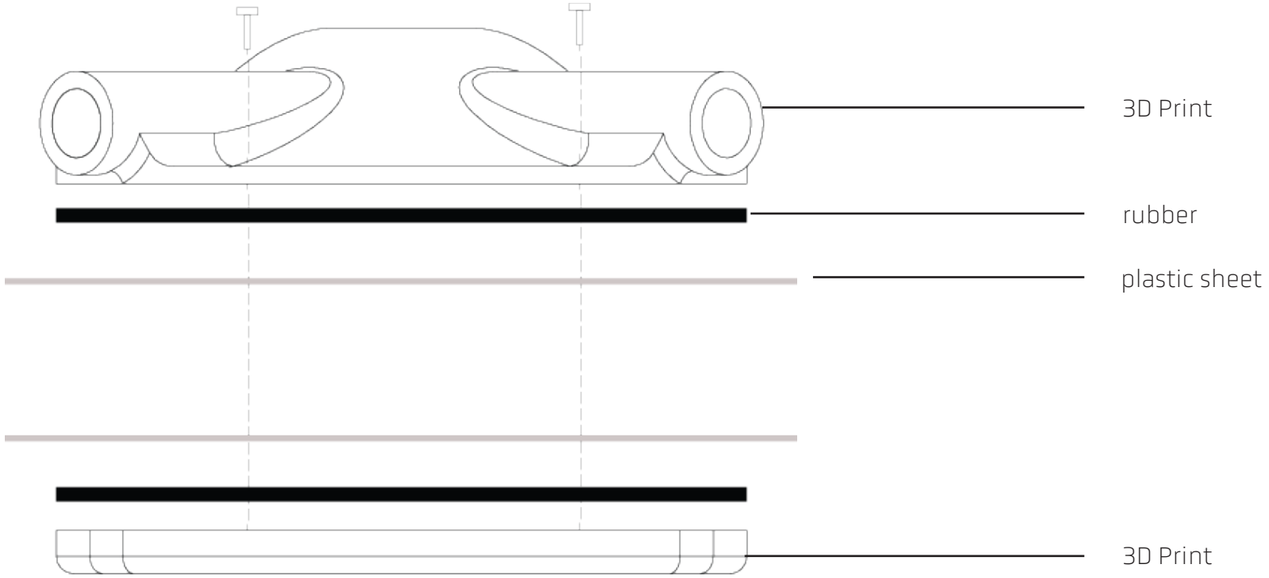


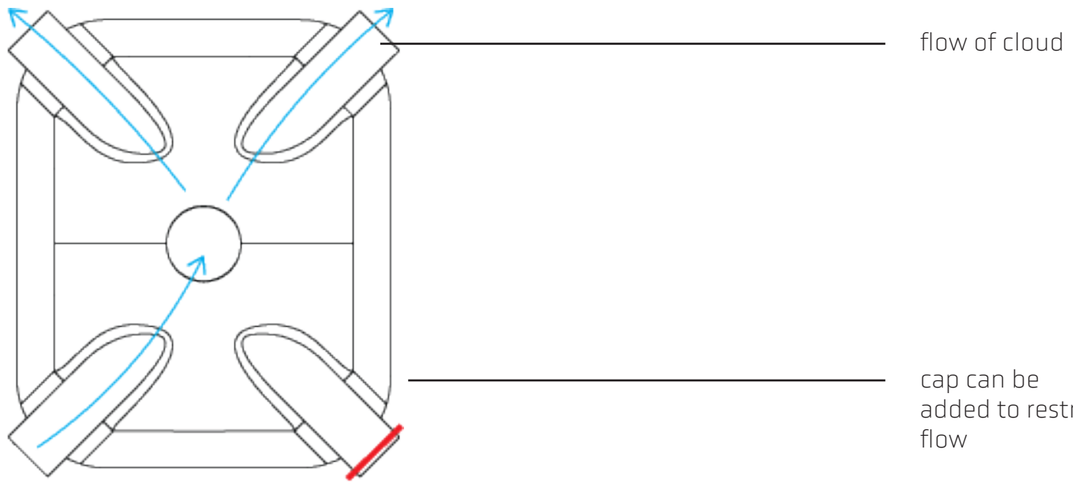
The first object is the puffer vest. This object is meant to produce a large cloud around the wearer inflating and deflating causing a large spectacle. While it does protect the wearer from being recognized the main intent is for it to create awareness. The wearer would be able to make this themselves and take it to a demonstration or wear it on the to draw attention to themselves.

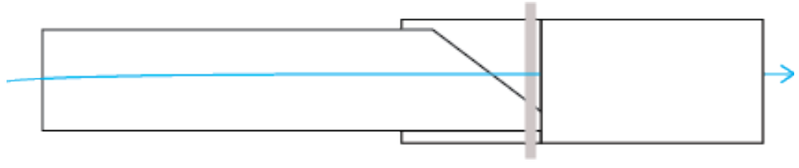
Making the Cloud

The cloud in this vest is made by using dry ice and warm water. This is a cheap way to make a very big cloud. The basic design of the vest is a series of modules that can be connected together. The modules are designed to be 3D printed and the files would be open source so the vest could be created anywhere in the world. The cloud would be created in a lower module and then it would flow through the modules to different parts of the vest inflating it in some areas and leaking out in others to engulf the wearer. Clouds that are made from dry ice tend to sink so this would create the effect of somebody rising out of a sea of clouds.

The first iteration uses a large 3D printed module that clamps around two plastic sheets. The sheets allow for an airtight chamber to be created inside for the cloud to flow into. A pin inside the module would pierce the plastic at the connection points to create pathways for the cloud to flow in and out. The modules could then be connected together in a pattern that fit the wearer. The main problem with this design was that it is too large to be 3D printed economically and it uses too many non printed parts like screws, tubes, and rubber seals.





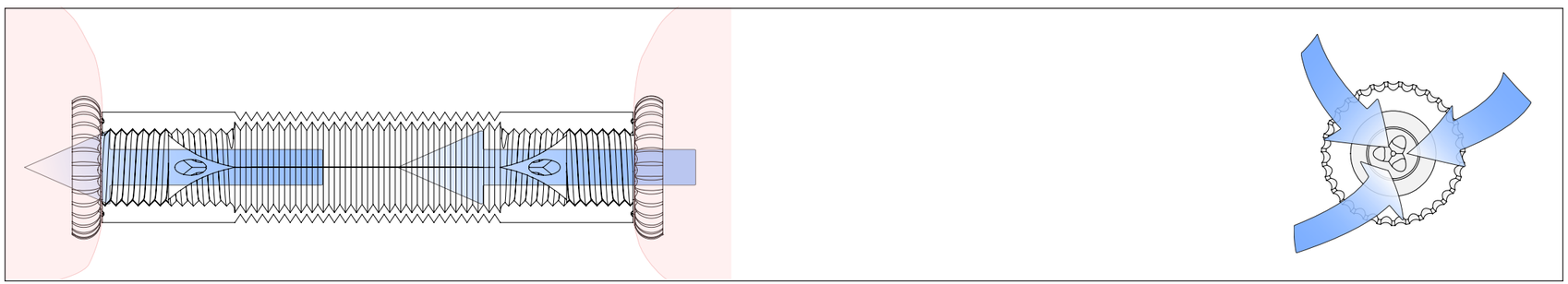


Two 3D printed parts screw together sandwiching two plastic sheets or a plastic bag between two rubber layers. Clouds can flow through the interior cavity created.

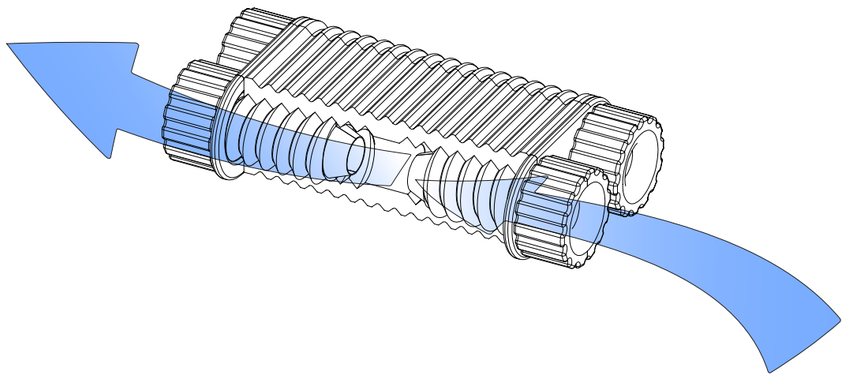
A 3D printed pin pierces the plastic and slides into the module opening. A seal is created and the cloud can flow through the module to the next one.

Design Iteration 02

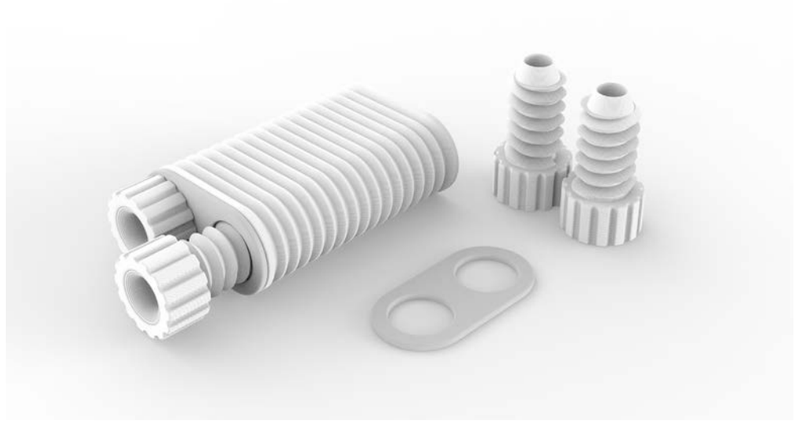
The second iteration is only used to make the connection between plastic bags. The screw pierces through the bag and into the connecting piece and an o-ring creates a seal between the bag and the part. A large ziploc bag would be the ideal material for this. The screws are hollowed out to allow the cloud to flow through. Ridges in the center allow for this module to be slightly flexible depending on the material that it is printed with. The original design was over 6 inches long so I shrunk it by half, but I still found it too bulky. This led to a much smaller final design.



Final Design



The final design is conceptually the same as the previous iteration, but each component has been optimized. The design is only 3”x 1.5”x .0.75”, much smaller than iteration 02. The single screw has been replaced by two smaller ones allowing for greater flow control. Using two screws also made the attachment area for the plastic bag larger so hopefully this design would also be more robust. A rubber plate is used to clamp the plastic bag to the module with the screws.

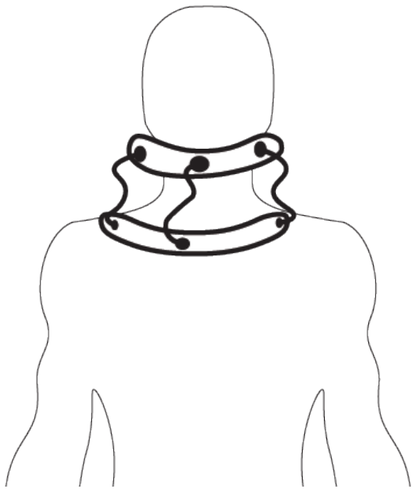


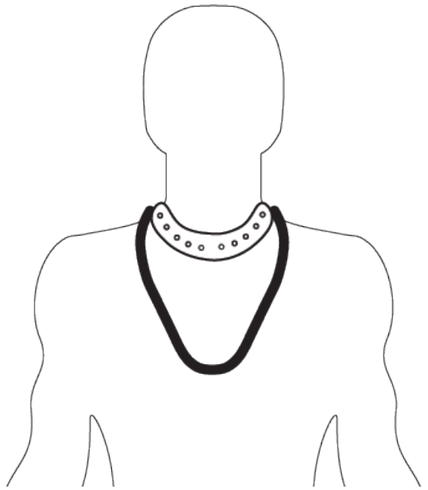
The modules would be used to attach multiple plastic bags together to create the vest. On the left is one configuration, but this could be customized to the user's desired fit. More modules could even be added to create a larger cloud. On the performer the cloud would inflate by first swelling up on their body and then spilling out of perforations in the upper bags, eventually fully enveloping them.

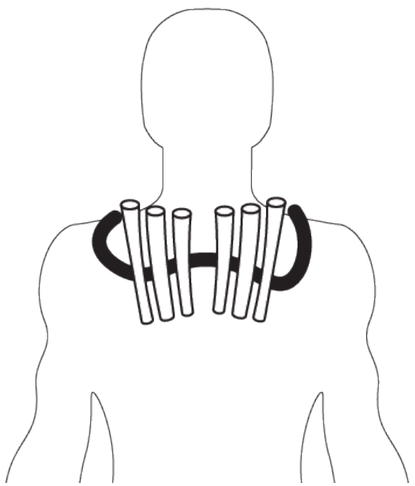
Spectacle

This vest is meant to create a spectacle. It would be used by a performer or activist to create awareness for the issues surrounding facial recognition. It could be used at marches, or it can be used to create its own gathering on the street. The vest would probably have to be paired with some other communication device like posters or speakers to educate people once they have been engaged by the spectacle.

4.3 CLOUD JEWELRY



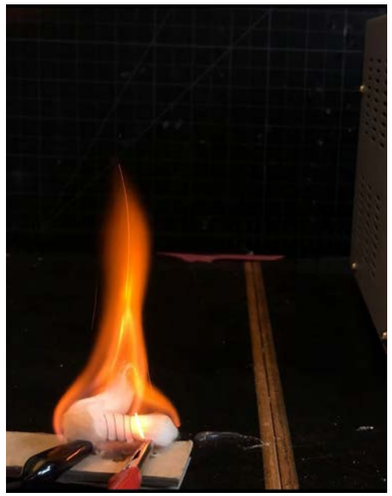


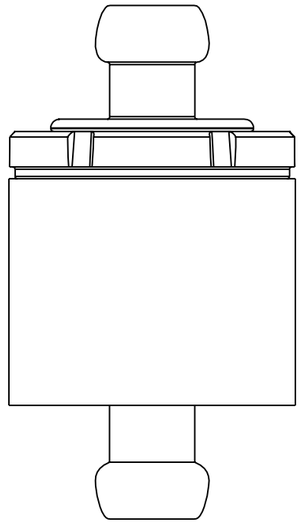


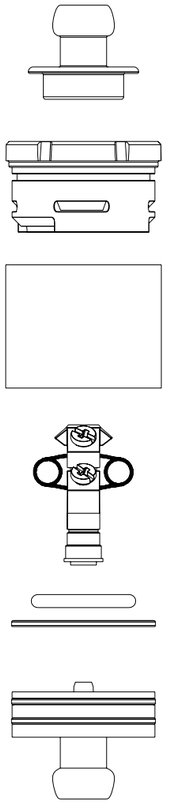
The second object is a necklace that creates a face concealing cloud. This is meant to be an inaccessible, high-end piece of jewelry. The cloud is subtly released in cycles from the necklace and the water vapor is meant to absorb infrared light, concealing your face from detection. This object brings the protest into spaces like fine dining restaurants, and galas. The inaccessibility makes it a desirable object, possibly even making this protest a coveted fashion statement.

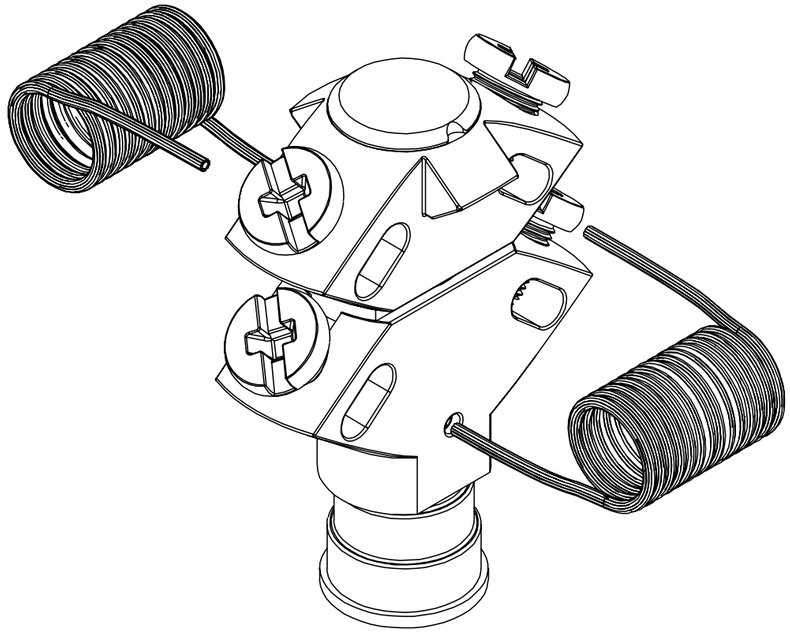
Making the Cloud

The cloud in this piece is made using an atomizer. An atomizer is essentially just a coil or resistive wire coil with a cotton wick through the center. The wick is soaked in a solution of vegetable glycerin and water. When a current is run through the wire the resistance causes it to rapidly heat up vaporizing the solution in the wick and creating a cloud. Since this cloud is heated it rises which is ideal for obscuring the face above the necklace. I did some testing of my own coil designs before the crisis struck to determine if this method would work and what the ratio of glycerin to water should be. The ratio that I came up with was 90% glycerin to 10% water. This created the thickest cloud possible. The coil testing did not go as well, and I started quite a few fires. Luckily atomizers are commercially available because they are also used in vapes. The final design uses a repurposed vape atomizer like the one on the facing page.





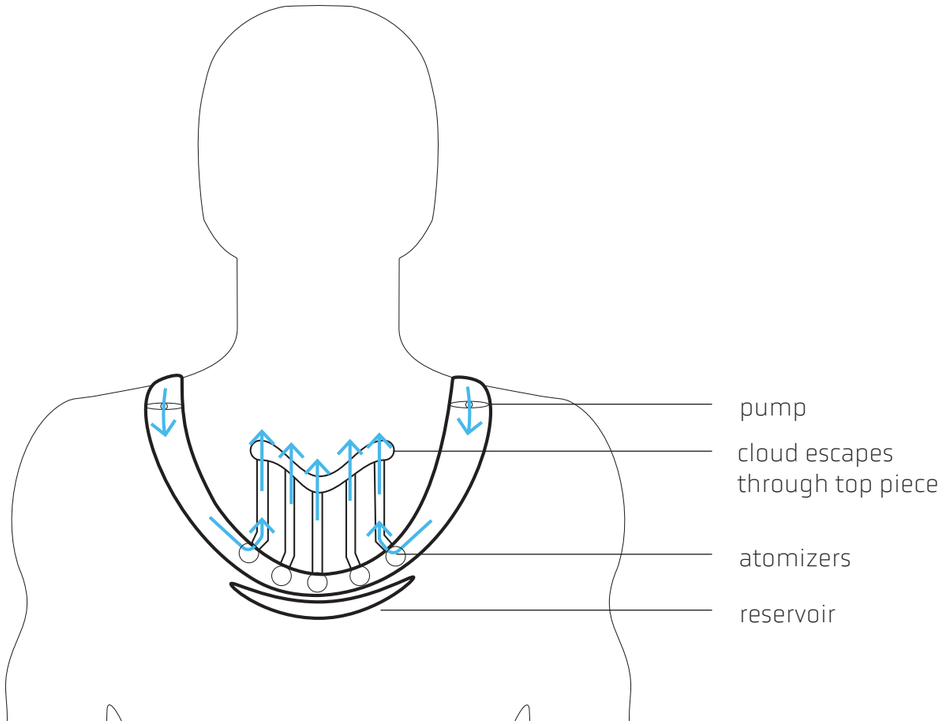


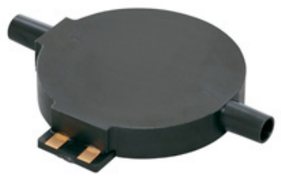


Drawing of a commercially available atomizer. This model uses two coils to heat two wicks and the entire body acts as a reservoir for the cloud liquid.

Basic Design

On the facing page is the first drawing that I made detailing how the necklace might work. In order for the atomizers to work air needs to flow through them so two air pumps pump air through the system. After going through the atomizer the air turns into a cloud which escapes out of the top of the necklace. The pumps and the atomizers would be cycled on and off by a microcontroller so that the coils do not overheat. The microcontroller as well as the batteries would be located at the back of the necklace.

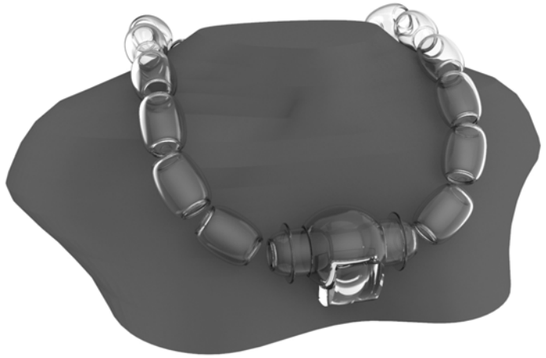


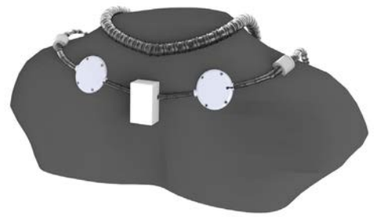


The pump used is a Murata Microblower MZB4001T05. It uses ultrasonic vibrations to move a membrane that creates airflow in one direction. This pump was selected because it is small and silent, but testing would have to be done to determine if it would actually work in the system.

Design Iterations

After getting an idea of how the necklace would work I explored a few different designs. I wanted the material to be borosilicate glass so that the cloud could be seen forming inside of the necklace. Borosilicate is ideal for lampworking which is how this necklace would be made and provides good strength as well. I explored two main directions one was an actual necklace and the other was more of a breast plate.



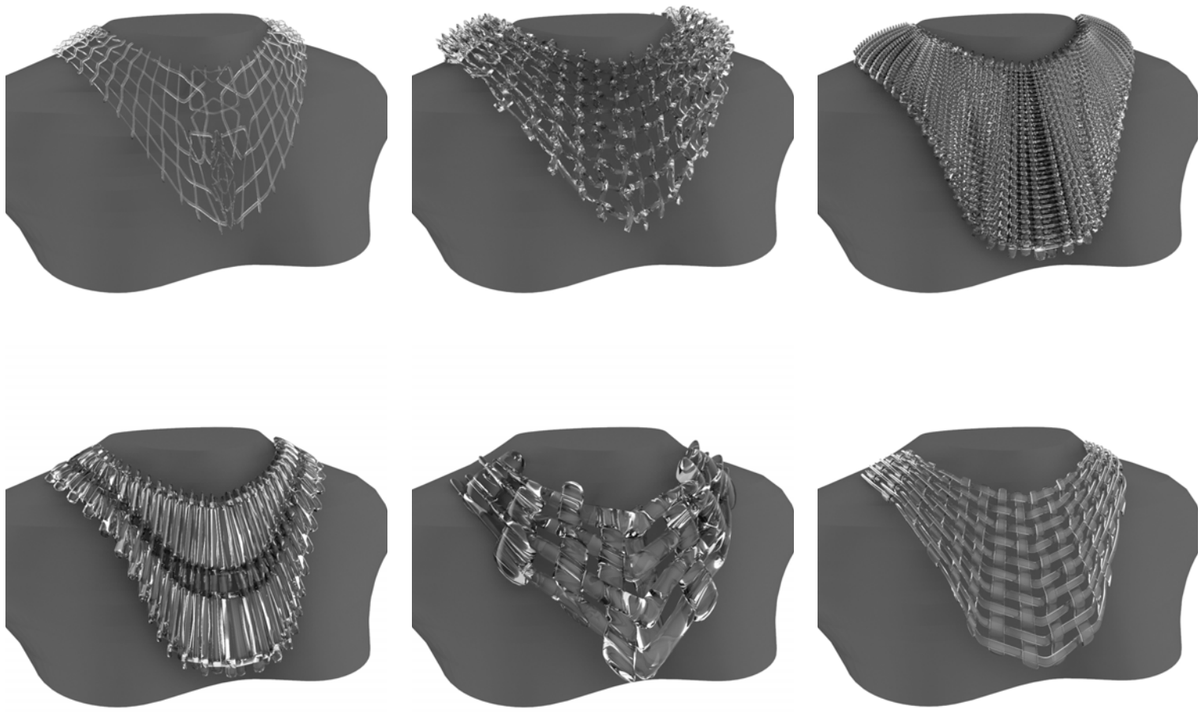


Necklace Designs

The first necklace design used multiple hollow beads to create flexible tubes for the cloud to flow through. The bottom design shows where the atomized, pump, and battery pack might sit. At this point I thought that I wanted the necklace to be more intricate so I moved on to designing the breast plate.

Breast Plate Designs

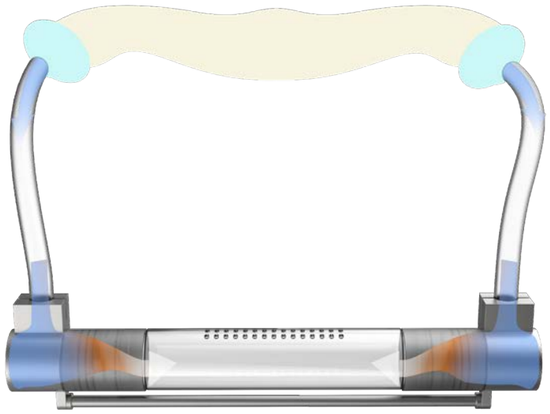
To make the breastplates I used rhino and grasshopper to come up with many different iterations. I wanted them to look like beautiful pieces of jewelry and not have them suggest any other function until they are filled with the cloud. I did not end up going in this direction in my final design, but I think if I were to continue this I would explore these more. These designs all omit the mechanical parts because I was more interested in the aesthetics, but they would be incorporated into the back so they do not distract from the intricate glass work.



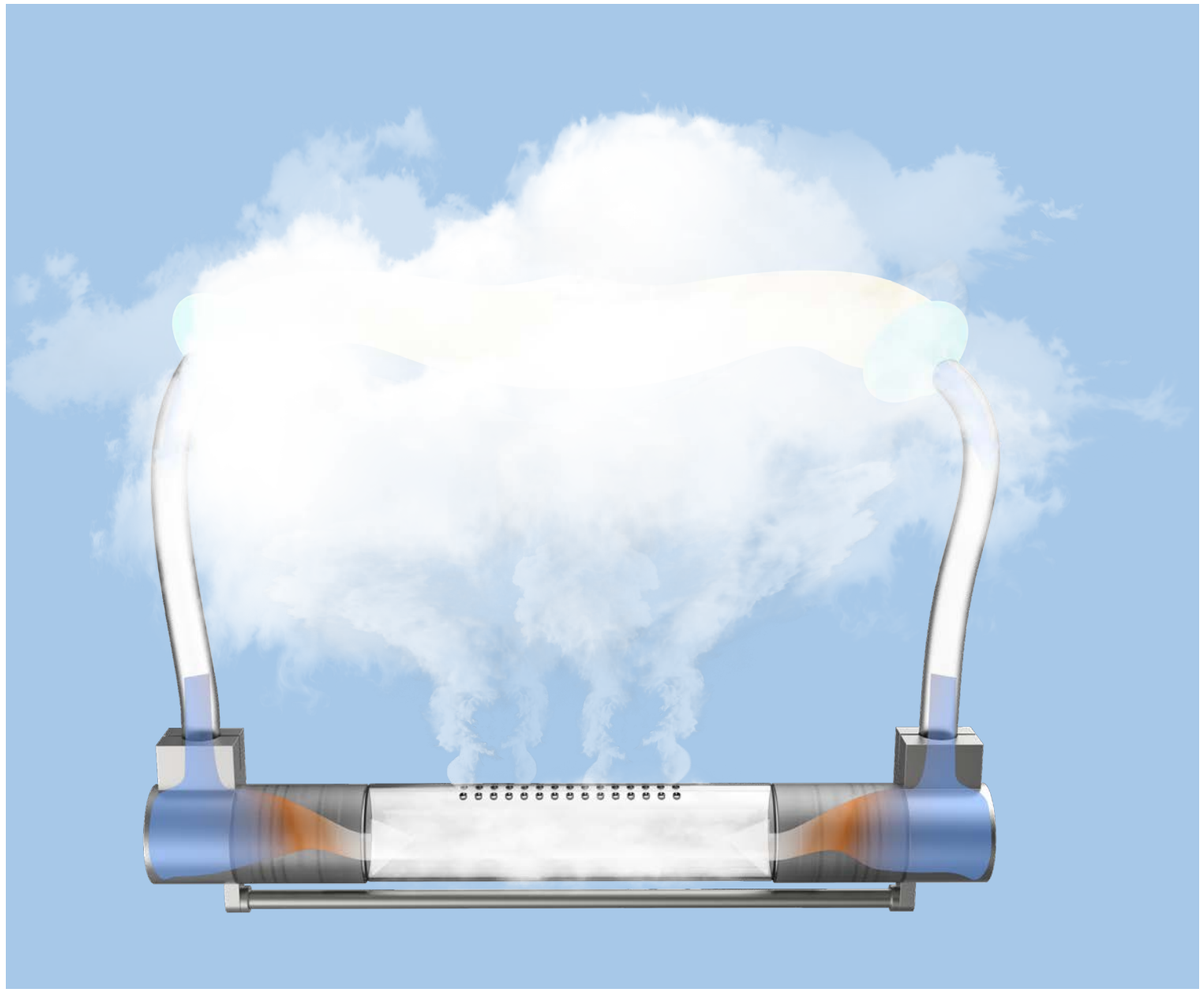
Final Design

For the final design I stepped back from the complex breastplates and decided to create a much simpler, but functional necklace. The entire thing could be made from machining aluminum and lampworking glass. The atomizers sit in the front and the central glass tube fills with clouds and releases them through holes in the top. The thin rod at the bottom is used to screw the whole necklace together allowing for easy maintenance of the atomizers.

The battery and the pumps sit in the back of the necklace. I did not have time to fully design how they could be incorporated, but it would be similar to earlier necklaces that had them. Instead, I have blocked out where they would be with the blue representing the pumps and the tan representing the battery pack and microcontroller housing.



Exploded View



The necklace works by pumping air through the tubes into the main body. It then flows through the heated atomizers picking up the clouds that they create. Finally, the cloud flows into the glass tube and out through the top, close to the face. The water vapor in the cloud then absorbs the infrared light from the facial recognition camera leaving a black spot where your face would be.

Accessibility

This necklace is meant to be sold as a luxury item and would not be accessible to everyone. I wanted a piece like this in the collection of objects because many of the people making the decisions regarding facial recognition are in the very upper class of society. I see this as taking the fight directly to this class by hopefully bringing awareness about this issue to people in similar positions of power. Hopefully this would spur faster change and for the issue to be taken more seriously This piece also raises the question of what happens if protest becomes limited to a certain class?

Image of what the Infrared Camera would see.

5. HOW WE PROTEST

I want these objects to question ways that protesting through object making can be achieved. What does it mean to take these objects into different contexts? How does the accessibility of these objects determine who can protest? How can objects make protest a spectacle? These objects work together to paint the bigger picture of the different ways we can protest as a society and I want each one to represent a different form that protest can take.

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