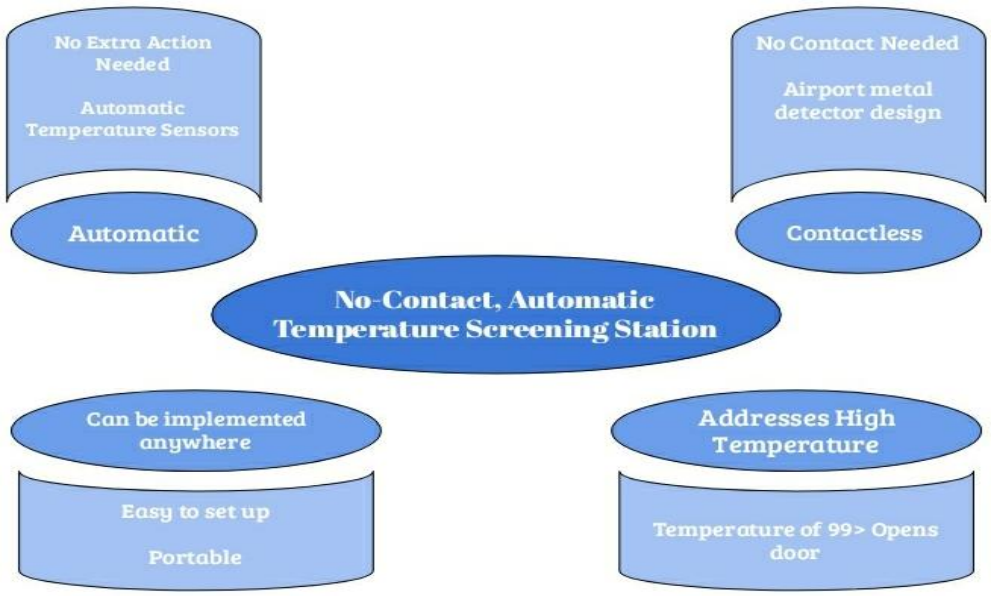
Final Project: Automatic Temperature Screening Station

Problem Statement:

Due to the COVID-19 infection outbreak, the public needs non-contact temperature sensing screeners to detect fever and limit the spread of infection.

Concept Map:



Three Solutions:

1) Final Solution: We will produce a product that contains a temperature screener that is located on the inside of an enclosure. The idea was based off of the metal detector sensing doors at the airport but for the temperature of a person to be measured contactless they need to be in an enclosed area so we upgraded our initial idea into something that's practical but also serves its purpose. The sensor located on the inside of the enclosure will detect the ambient temperature in the enclosure after a couple seconds of sensing with the individual inside of the enclosure. If the ambient temperature is above the average of the temperature collected in our experimental data, the servo will not permit access through the gate. In comparison, the gate will open if the temperature is equal to or below the average calculated in our data.

2) Non-Final Option: Sensors located on the ceiling like fire alarms that are coded to detect a temperature of 99 or higher within a set circumference. Once the sensor

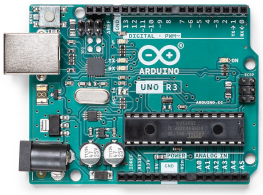
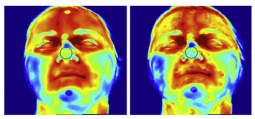
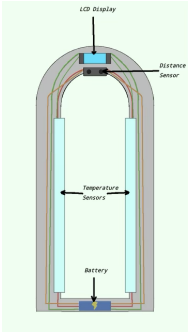
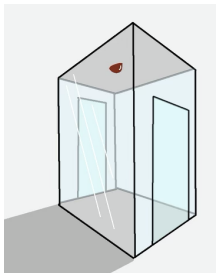
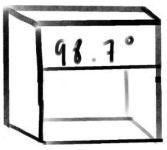
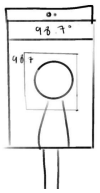
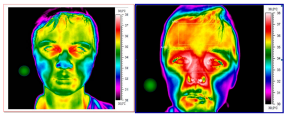
detects the fever, it will go off and detect the distance the person is from the sensor. This would be easier to detect the person. The sensor would beam a non-harmful laser around the area the individual is located.

3) Non-Final Option: The sensor will be placed on each side of an airport metal detector style door. The result of the person's temperature will trigger a flashing light of red or green at the top of the door depending on the results.If the individual's temperature is above 99 degrees fahrenheit, they will be denied access through the door shown by a red flashing light at the top.We would also have someone standing at the door looking for the red/green light as the individuals approach allowing or denying them access depending on the light. In addition, there will be a sensor placed on the top of the door that detects the distance a person is from the sensor. The distance sensor will alarm the temperature sensors to start sensing once a person is approaching. The reason why didnt pick this option was because the distance sensor wouldn't serve any purpose because the temperature sensor would not be able to detect temperature until the individual was walking through the door. Ideally, there would be an interactive screen that shows the generated temperature, and will deny or permit access to the other side of the door.

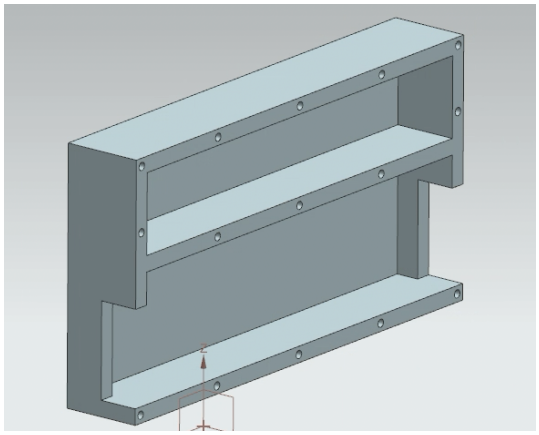
Heuristics used:

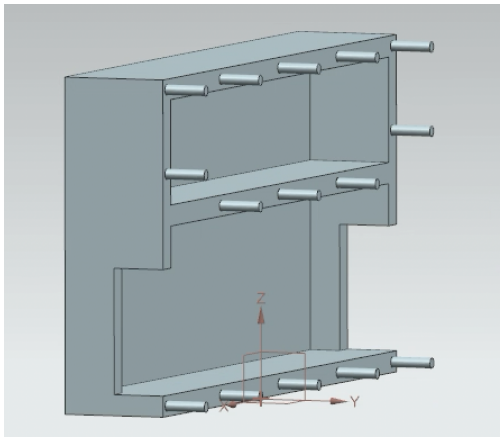
We first started by generating ideas of possible solutions for the given problem. We eliminated ideas that we thought were not as necessary for this project. For example the distance sensor would't ideally work because no matter at what distance the sensor detects an individual the temperature sensor would not work until the person was walking through the door.Another reason why our second and third option were not ideal because in order for a person's temperature to be accurately measured, they have to be in an enclosed space which were not taken into consideration for these options. In addition, we decided that the sensors on the ceilings were not as practical. Even though these sensors would detect individuals with a fever, it may not accurately sense a singular person at one time and resulting in an ineffective systematic way to detect the temperature. Also, for these sensors to work we would need more of a confined space so that the temperature sensor would detect one person's temperature at a time. In an open space, the sensor will try to record temperatures of multiple people at one time and result in an inaccurate reading. The option we picked was the most practical because it was an effective way to measure someone's temperature without coming into contact with them. Furthermore, our system eliminates any human interaction by putting an automatic servo at the entrance door. The servo denies access if a temperature over 99 degrees fahrenheit is detected.

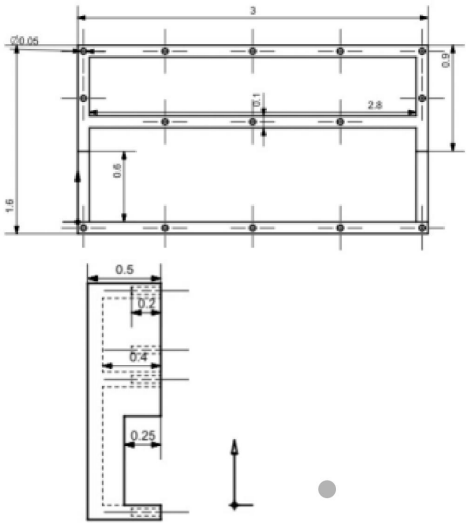
Morph Matrix

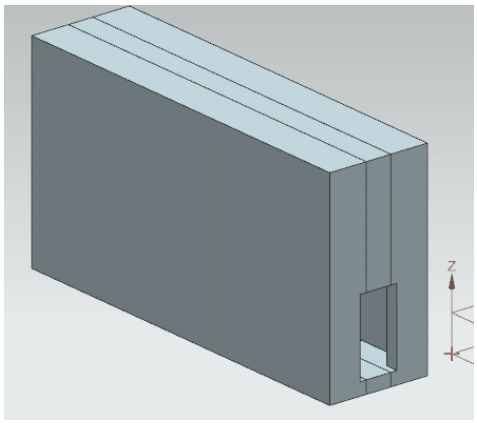
	Option 1	Option 2	Option 3
Automatic	 Arduino board which uses wires	 Non-contact Infrared thermometer which immediately displays temperature using color	Computer programmed software
Can be implemented anywhere/accessible	Portable non contact sensor that can be applied to any flat surface	 Lightweight, portable archway-door with built in sensing technology that can accomodate any size/height	 Handheld temperature screener that gets temperature from contact with wrist/forehead
Contactless	 Walk through a door with a temperature sensor on it	 Put wrist under a temperature sensor for a few seconds	 Screen with surface that displays thermographic image, which shows temperature
Addresses high temperatures	Temperature sensor	 Thermography	 Thermometer

Description, pictures, images of the 3D printing components:







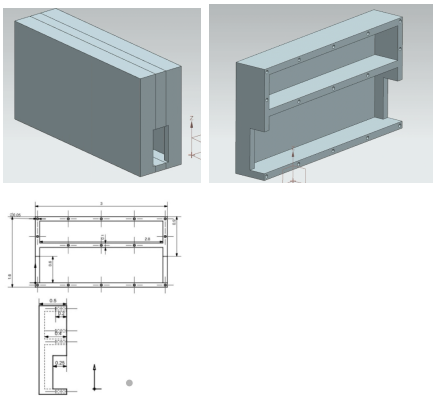


The model is composed of two pieces, which are meant to be assembled together. When making the 3D print element of our project I decided to create an component that is functional, portable, and easy on the eyes and I feel that our design prototype hits all of those points, being that this model can easily be opened and accessed with a special compartment made to hold the wiring components to avoid an ugly looking model.

Why this solution was chosen: One of the most pertinent crises to address around the world and in our country at this point in time is to stop the spread of the COVID-19 infection. Limiting the amount of people around us with this infection by detecting fever is one way we are able to work towards reducing the spread. Hence, we took our

knowledge of temperature sensors and the overall well being of the public into consideration when creating our design to address this issue. Our concept was created to eliminate the spread of Covid-19 in large crowds and through physical contact. Knowing the importance of minimizing human interaction, we created a product so that temperature sensing was contactless. Our initial idea for our design originated based off of airport security metal detectors that exist in airports. We based our design off of these detectors since they are also contactless and sensor an individual walking through. However, the airport metal detectors still involve human interaction which was one factor we had to consider when creating our design. To overcome this barrier, we implemented a servo at the entrance of our door to act as a gate to enter and exit based on if access was granted. Access is permitted if the individual does not have a fever (below 99 degrees fahrenheit). Since the temperature sensors we used measure the ambient temperature, we created our product in a boxed, enclosed space. If the ambient temperature is above what was collected in our experimental data, the gate will deny the individual access. We chose to implement this idea into our design because it also eliminates the need for human interactions. Since the main problem we are attempting to solve is to limit the spread of infection by monitoring temperature, it is also important to consider reducing human interaction by creating a design that eliminates the need for additional people. Overall, our solution to limiting the spread of the COVID-19 infection through temperature screening is practical and effective. Additionally, if our product was commercialized in public areas, this would help stop the spread of Covid-19. Not only would our product help with Covid-19, but it would also stop the spread of the flu and other viruses where one of the symptoms is fever.

Design Inputs, Outputs, User Needs:

User Needs	Inputs	Outputs
Automatic	No extra action needed Automatic temperature sensors	Arduino board which uses wires and a program to report temperature on a screen
Can be implemented anywhere/accessible	Easy to set up Portable Affordable	 Polycarbonate Plastic, 12V/36W External Power Supply, Room Temperature and Humidity Sensor (Acurite)
Contactless	No human contact or physical interaction needed	Walk through a 3D printed door with temperature sensors implemented along the sides and on the ceiling
Addresses high temperature	Reports temperatures applicable to humans rather than room temperature Notifies if temperature is above average	An arduino temperature sensor located on the inside of the enclosure will detect the individual's temperature in the enclosure after a couple seconds of sensing with the individual inside of the enclosure. If the individual's temperature is above the average of a healthy human, the servo will not permit access through the gate. In comparison, the gate will open if the temperature is equal to or below the average calculated in our data.

Cost Analysis:

- **Structure**:
  - Model
    - Model Mass: 0.296784 lbm
    - Model Volume: 1.8280 in^3
    - Model Dimensions:
      - Total Height: 1.6 in
      - Door Height: 0.6 in
  - Life Size
    - Scale from Model:
      - Standard door height is 80 in.
      - 0.6:80 = 3:400
    - Life Size Mass: 39.5712 lbm
    - Life Size Volume: 243.73 in^3
    - Life Size Dimensions:
      - Total Height: 213.3 inches (17.75 ft)
      - Door Height: 80 inches
  - Material: Polycarbonate Plastic
    - Price: $2.50 per pound.
    - Total Structure Price: $98.92

- **Sensors:**
  - Room Temperature and Humidity Sensor: $15.99 (Acurite)

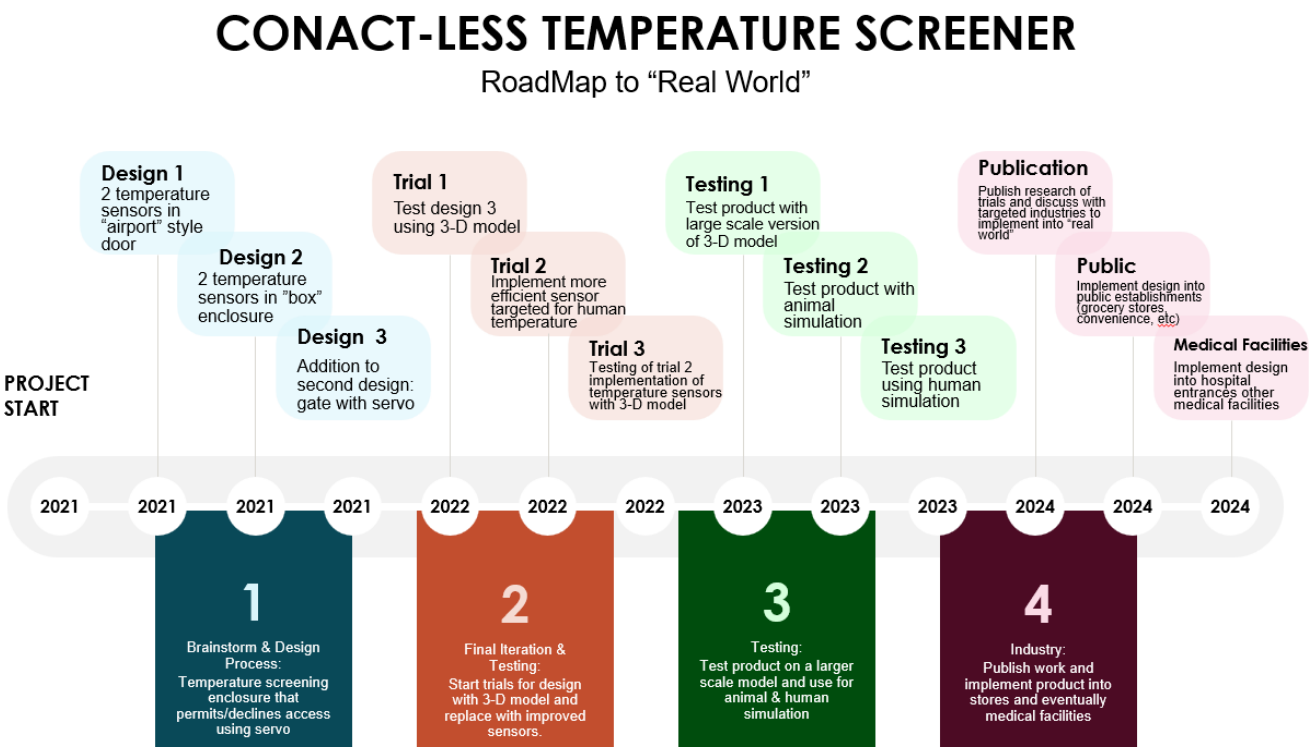
- **Power Supply:** 12V/36W External Power Supply
  - Price: $25
- **Total Price:** $139.91

Future Direction:

In the future, the design could be improved by adding more features making it more practical for people with special circumstances to use. One modification to the design could include using a material that is translucent so that the individual inside the enclosure would be able to see through the walls. This would be beneficial when taking into account individuals that are claustrophobic. Furthermore, including a noise activation device in the design would be a valuable modification for individuals that are blind. In future iterations, developing a more simplistic version of our design would be more cost efficient and practical for implementing our product in the real world. This could be done by using just the sensor that would be attachable to a door. The sensor would be a thermal sensor that would sense the human's temperature as they step towards it and wait for a noise representing that their screening is complete and displays the value on a screen.

Before making this product public, we would have to perform some testing to make sure this product is safe for use. One way that we would be able to test this is by having animals such as mice that would go through the enclosure. This would make the most sense since animals have similar average body temperature in comparison to humans. After our testing trials, we will be able to have our product commercialized for it to start off in areas such as airports, grocery stores, schools and other areas with confined public masses of people. As the product's functionality is improved over time with more precise sensing and technological advances, we will eventually be able to put our product in hospitals and health administration buildings**.**

Timeline to the "Real World":



Our Team:

R&D Engineer: Our R&D Engineers were Mia and Marina — they assisted in largely coming up with the product concept, and researched possible ideas to test to improve the efficiency and design of our product. For our company, they would be tasked to continue coming up with new ideas and also helping improve our current products.

Quality Engineer: Our Quality Engineers were Aya and Camellia. They focused on ensuring the product satisfied its duty and did so efficiently. In our company, they would focus on making sure our products comply with both proper engineering safety regulations and the expectations of the market.

Process Engineer: Our Process Engineer was Moe. He focused on using the materials given to design, test, and make improvements in order to finally create our product. Using our ideas, in our company he would create them on the three-dimension in order to implement them in the real world.

Product Manager: Our Product Manager Muhammad. He was responsible for the business side of our product, and managing the timeline of bringing our product to the market. In our company, he would deal with the economics side of engineering and look into the best time and way to launch our products.

References

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https://www.sciencenews.org/blog/gory-details/your-fear-written-all-over-your-face-heat

https://www.mdpi.com/2313-433X/2/2/13/htm