The Decontamination of Pathogens From N95 Masks

Wright State University
Biomedical Engineering

Abdullah Albutain, Cody Clark, Alexis Lemieux, Macy Wallace, Robert Youtsler

D'Angelo Technologies, LLC

CONTEXT

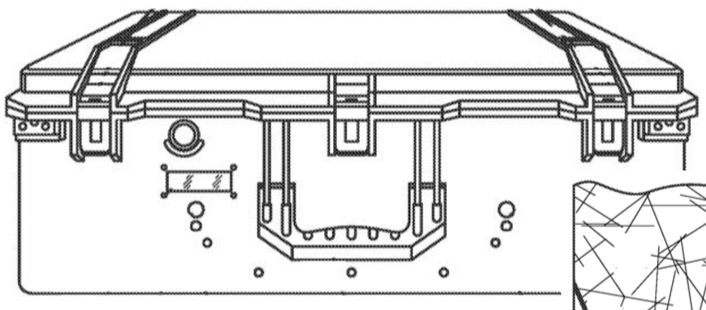
The Covid-19 pandemic took the world by storm and highlighted issues with current supply chains at home and around the globe. Healthcare and other facilities started to reuse and sterilize personal protective equipment such as N95 masks. The techniques used were inefficient, costly, and degraded the material. The need for new decontamination methods were clear.

PROBLEM STATEMENT

Engineer a novel decontamination unit that implements UCV lights, Blue light LEDs, and an electrostatic field while still being portable and straightforward for use by the general population.

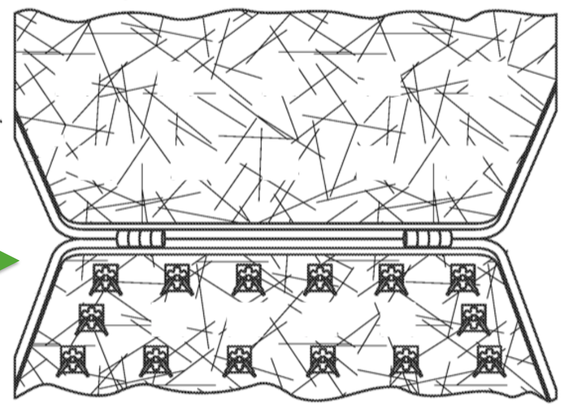
METHODOLOGY

An initial decontamination unit based on a patent from the client was provided to the team. The unit contained working UVC and Blue light LED systems. The main goal was to implement an electrostatic field.



Outer Shell of Unit

Interior Light Arrangement



The design was created with safety and effectiveness in mind. The top of the unit was charged to 10 KV while the four sides and the bottom of the unit were grounded. This is what enables an electrostatic field for run within the unit. Locks were placed on the lid to ensure that the unit could not run while open. Additionally, a switch was placed on the exterior of the unit in order to transition between the UVC/Blue light system and the electrostatic field.

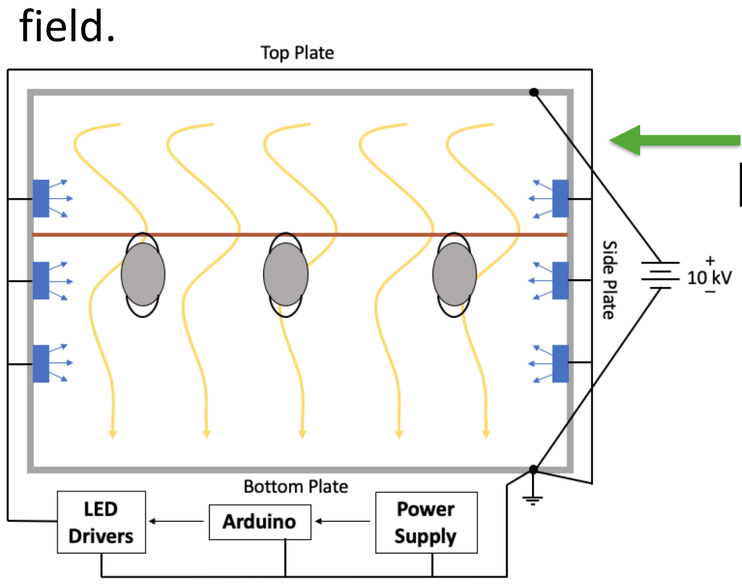
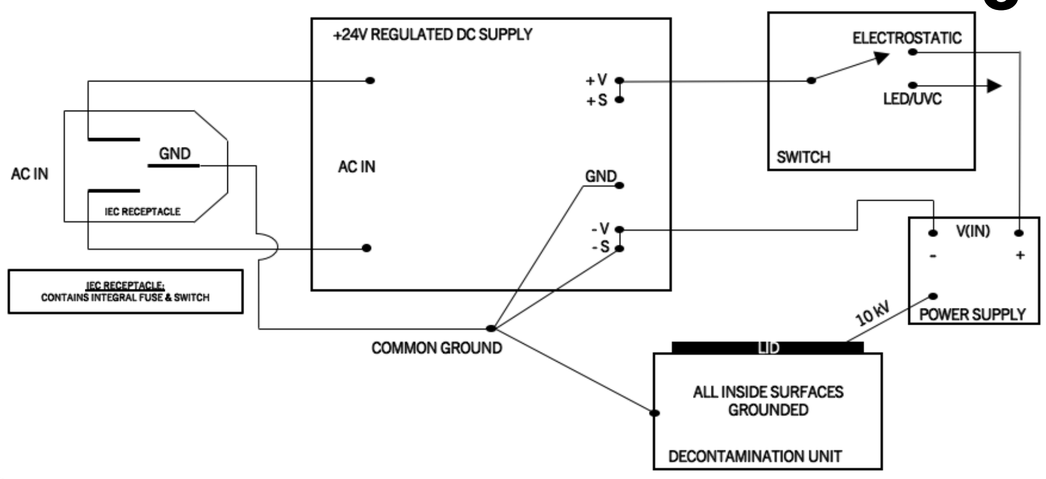


Diagram of Final Design

Key
Reflective Sides
Light
Mask
Copper Rod
Wire
Electrostatic Field

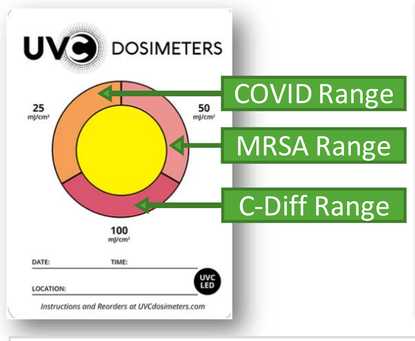
Electrical Schematic of Final Design

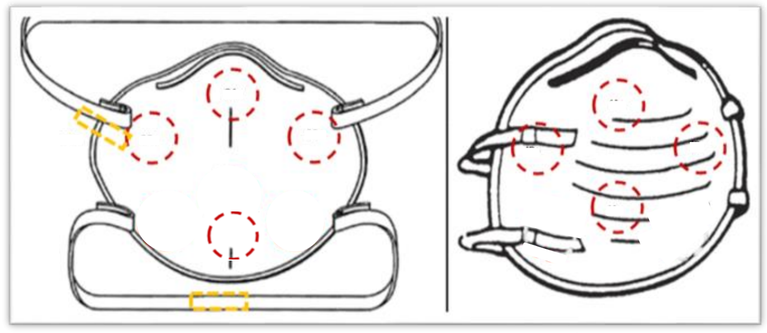


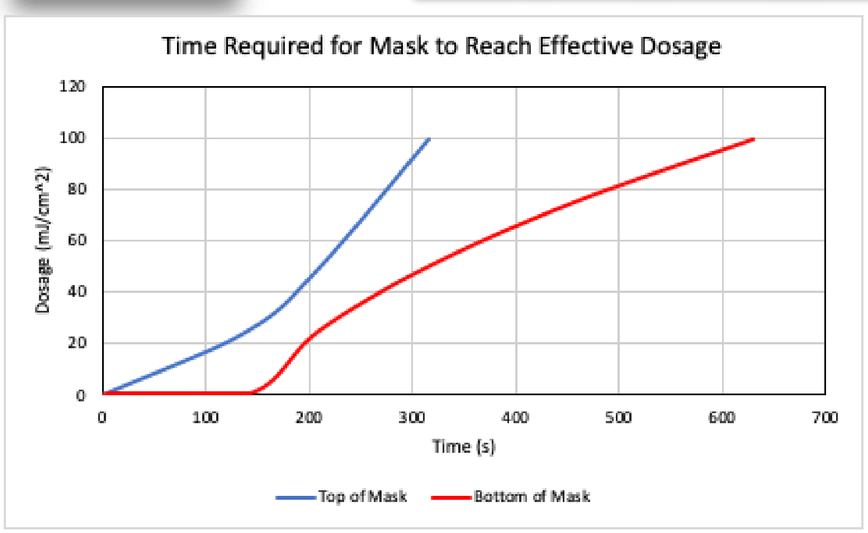
TESTING

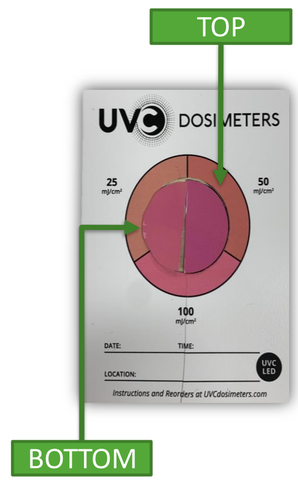
The decontaminated unit was evaluated to confirm that the light systems and electrostatic field worked properly to produce a log-3 reduction rate and an effective charge & filter efficiency, respectively.

Log Rate

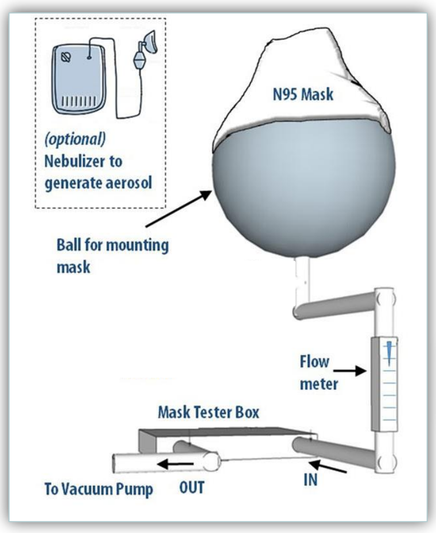








Charge & Filter Efficiency



Before Recharging

Mask Type	|Charge| (nC)	Filter Efficiency
Unused	2.44	81.71%
Used	0.50	52.26%

After Recharging

Mask Type	|Charge| (nC)	Filter Efficiency
Used	2.47	–

Vernier Go Direct Static Charge Device

$$\eta = (1 - \frac{N_{mask}}{N_{ambient}}) \cdot 100$$

Filter Efficiency Equation

DISCUSSION

Challenges related to methods for measuring electrostatic charge were solved utilizing a Vernier Go Direct Static Charge Device. Issues relating to filter efficiency testing and wireless internet sources interfering with the sensor's signal were also solved. Lastly, shortcomings related to shadowing were solved with a creative shelf design.

CONCLUSIONS

An effective decontamination unit with UVC and blue light LEDs and an electrostatic field was engineered by the team. The unit may be produced commercially or serve as the basis for further research by DOD or other customers. Future steps would be to outsource live pathogen testing.

ACKNOLWEDGENEMTS

The team would like to thank Joe Tritschler for assisting with the implementation of the electrostatic field and for being an excellent advisor; Tony Tritschler, BME Lab Manager, for supporting prototype modification; Joe D'Angelo for providing the project and for serving as the client; and Robert Myers for instructing the Senior Design Class.