Resizable 3-D Printer Enclosure to Contain Aerosol Emissions that are Harmful for the Human Body

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Background

- 3-D printing emits aerosols, such as Volatile Organics Compounds (VOCs) and Ultrafine Particles (UFPs,) that can be harmful if inhaled
- Enclosures are used to capture aerosol emissions but not a single enclosure in the market can resize to any 3-D printer size and brand

Project Impact

- Protects users from inhaling harmful aerosols
- Provides safety for surrounding public
- Enhances air quality of an indoor environment
- Provides the 3-D printing society with a user-friendly protective product

Project Objective

Design and construct a resizable enclosure that will capture 90% of the number concentration of aerosols produced by tabletop appliances with a volume range of 8 to 27 cubic feet

Design Requirements

- Resizable in 3 axes with dimensions of 2 ft, 2.5 ft, and 3 ft
- Accommodate 95% of tabletop 3-D printers
- Enclosure must be lightweight
- Easy accessibility into the inside of the enclosure and filtration system
- Capture 90% of the particles larger than than 0.3 µm per unit volume

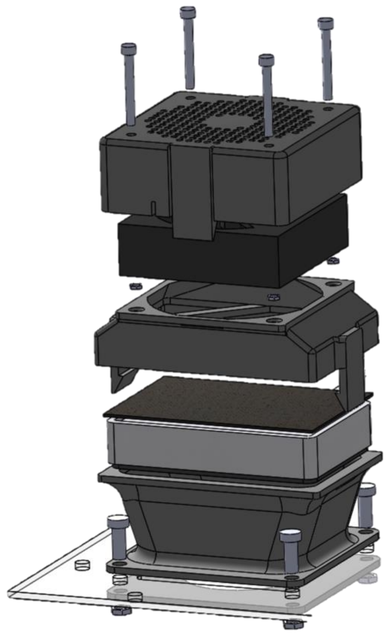
Acknowledgments

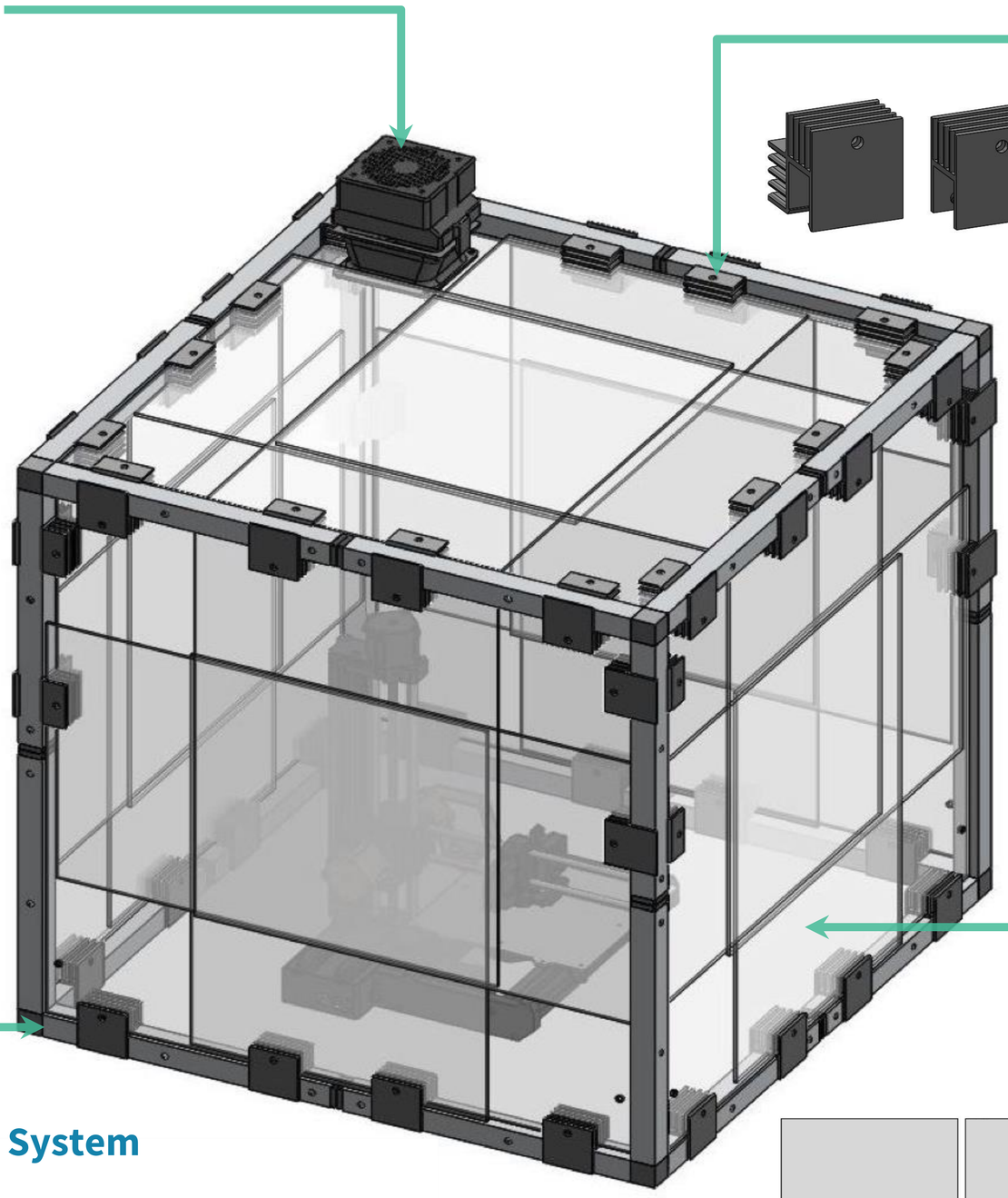
All Metals and SSD Plastics

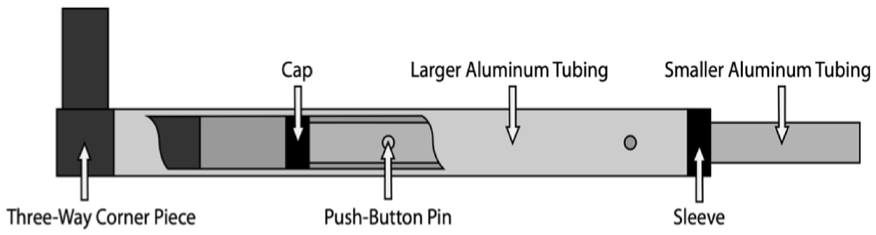
References

Panu Karjalainen, Sampo Saari, Heino Kuuluvainen, Tapio Kalliohaka, Aimo Taipale & Topi Rönkkö (2017) Performance of ventilation filtration technologies on characteristic traffic related aerosol down to nanocluster size, Aerosol Science and Technology, 51:12, 1398-1408

Design



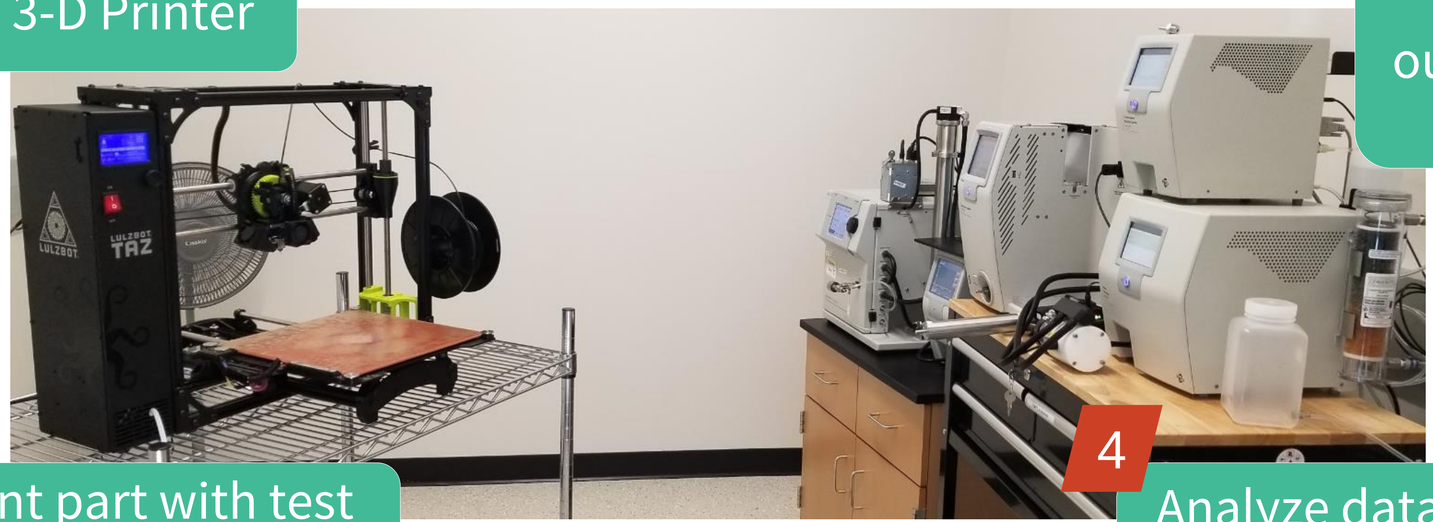




Design Evaluation

Experimentally test the enclosure's filtration efficiency

1 Enclose 3-D Printer



2 Print part with test parameter*

3 Collect emissions outside of enclosure in room chamber

4 Analyze data and repeat for different test parameter*

* Test Parameters:

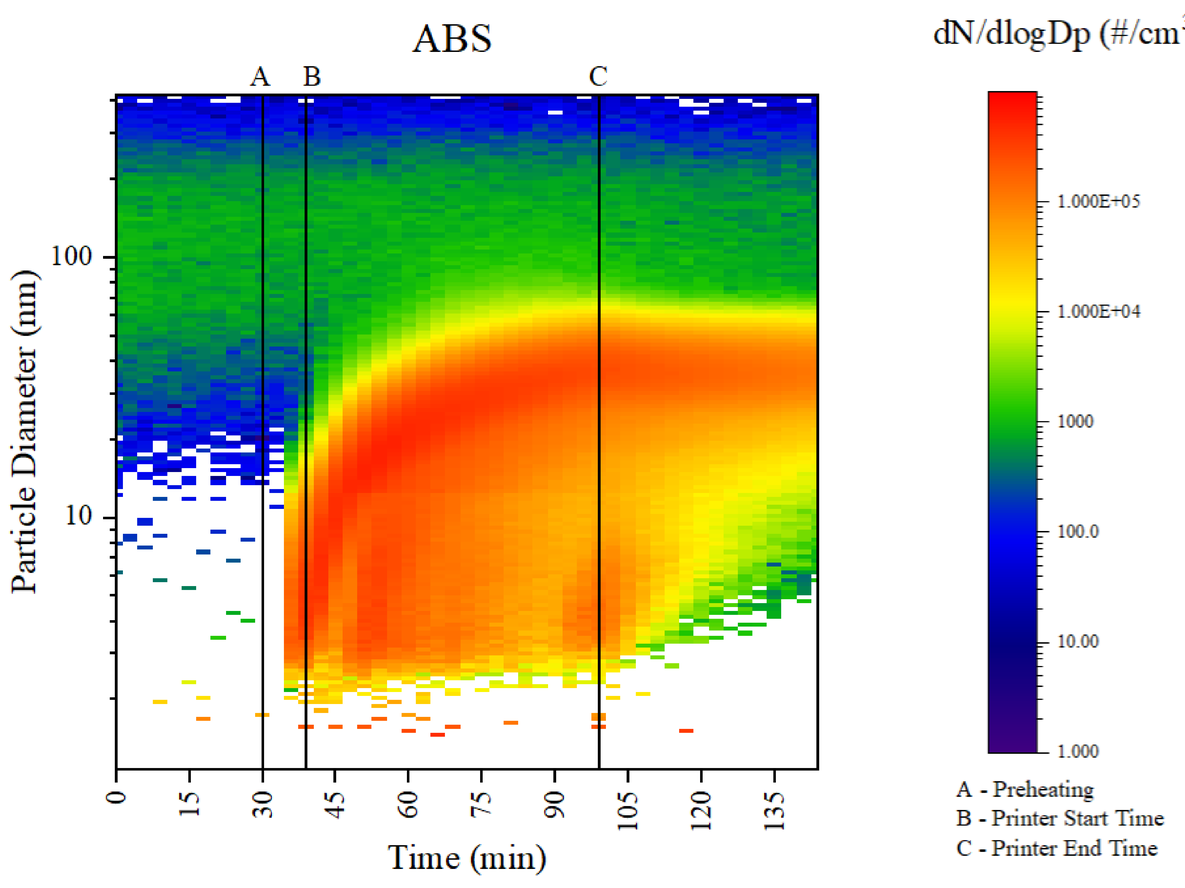
- Test different filaments (ABS, PETG, PCPTE)
- Test the number of filtration systems being used in parallel (maximum of four)
- Test different enclosure volumes (8 ft^3, 15 ft^3, and 27 ft^3)

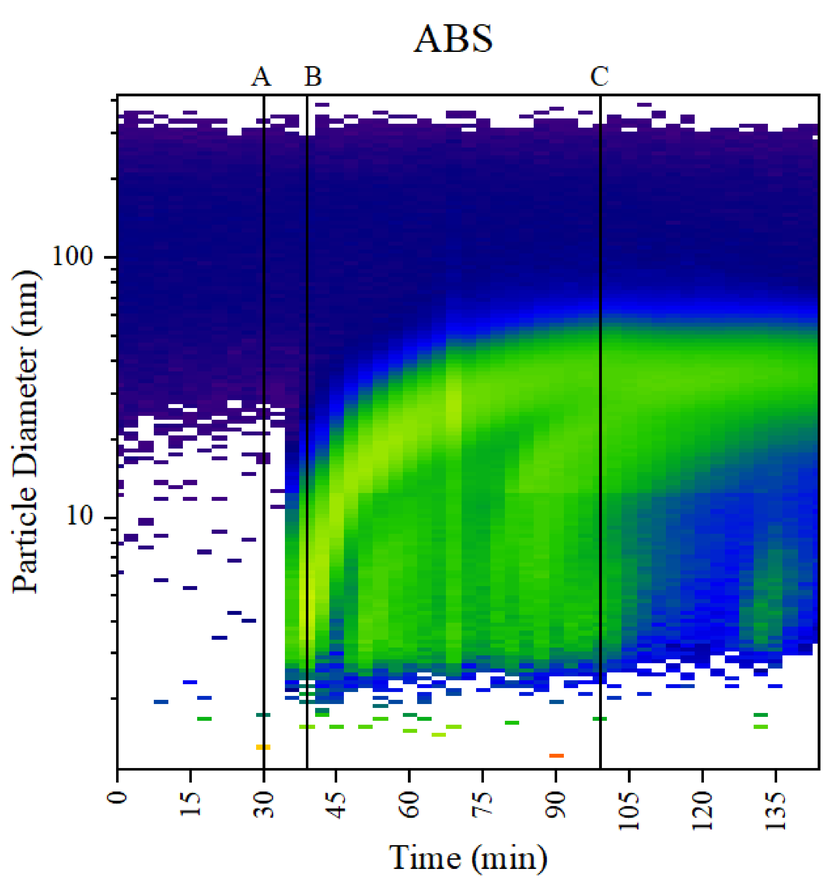
Results

Experimental vs Theoretical Model

Experimental data of aerosol emissions produced by ABS filament within an airtight 34 m^3 chamber without an enclosure.

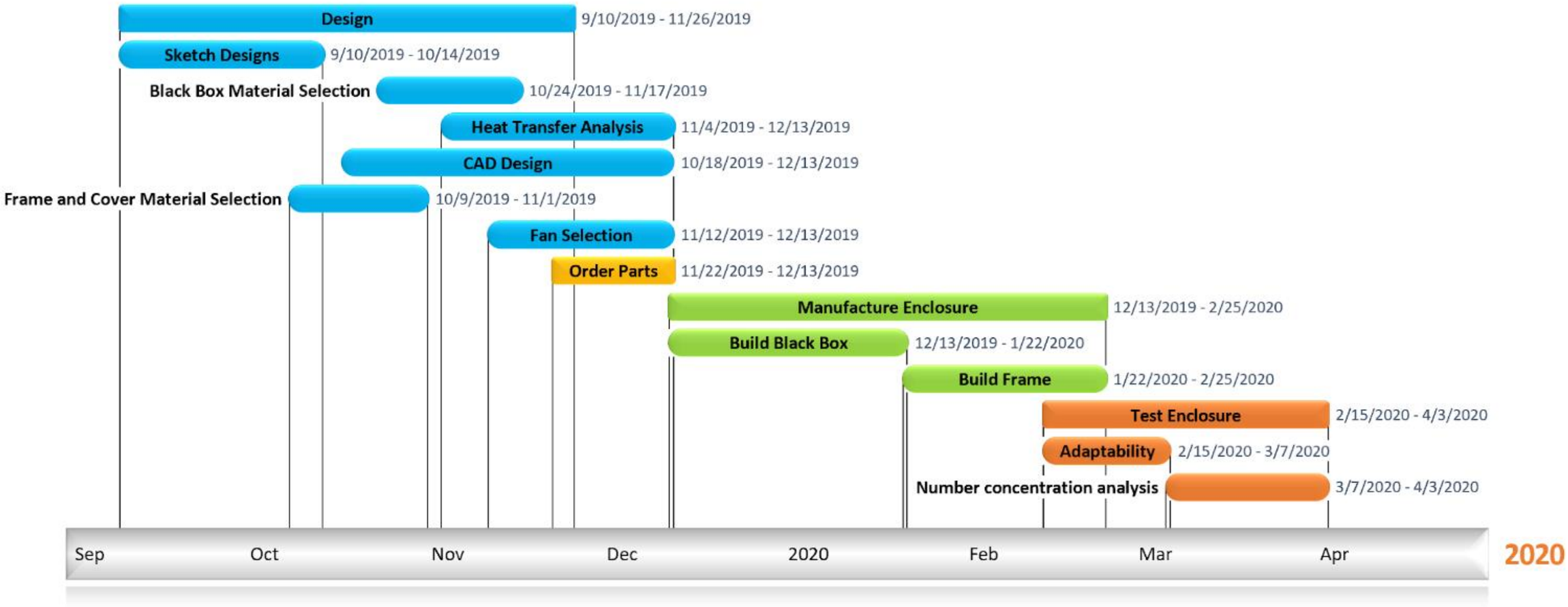
Theoretical data of aerosol emissions produced by ABS filament within an airtight 34 m^3 chamber while using an enclosure with a HEPA filter (filtration efficiency >99%, Karjalainen et al., 2017)





Budget/Timeline

This project was $1,129.15, which is $870.85 under our $2000 budget



Conclusions/Next Steps

Future enclosure improvements

- Lightweight material
- Magnetic system
- Resizable system

Market Potential

- Only resizable enclosure on market
- Parts have the ability to be mass produced
- Secondary use as a room air purifier