Team 510: Indoor Air Quality of Hotspots

January 28th 2021

Eric Grogans, Leon Johnson, Emma Martin,
Razhan Matipano, Whitley Pettis

Team Introductions

Eric Grogans
Electrical Engineer

Leon Johnson
Test Engineer

Emma Martin
Project Manager

Razhan Matipano
Research Engineer

Whitley Pettis
Manufacturing Engineer

Razhan Matipano

Sponsor and Advisor

FAMU-FSU College of Engineering

Honeywell

Engineering Mentor
Alfred Guerrero
Honeywell

Engineering Mentor
Danny White
Honeywell

Engineering Mentor
Danny Mims
Honeywell

Academic Advisor
Neda Yaghoobian, Ph.D.
Professor

Senior Design Professor
Dr. McConomy, Ph.D.
Professor

Razhan Matipano

Objective

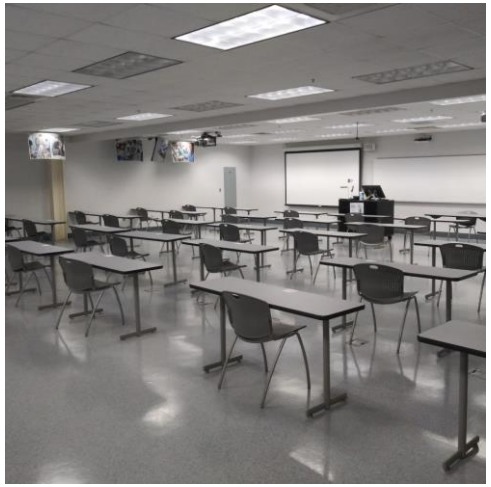
The objective of the project is to measure the air quality in the FAMU-FSU College of Engineering and modify the air based on these findings to promote a healthy building environment.

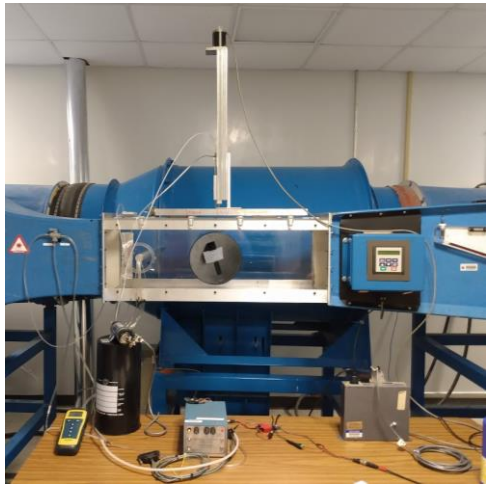
Razhan Matipano

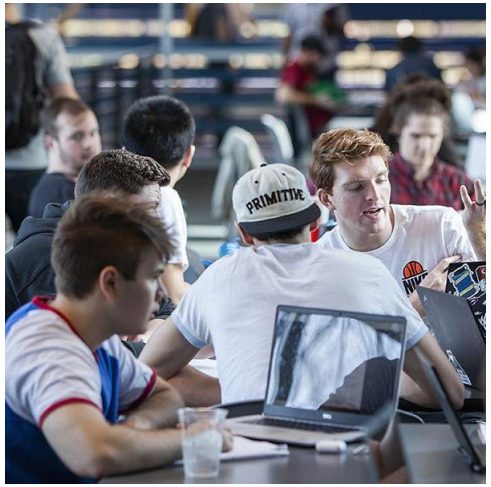
Project Recap

Razhan Matipano

Project Background







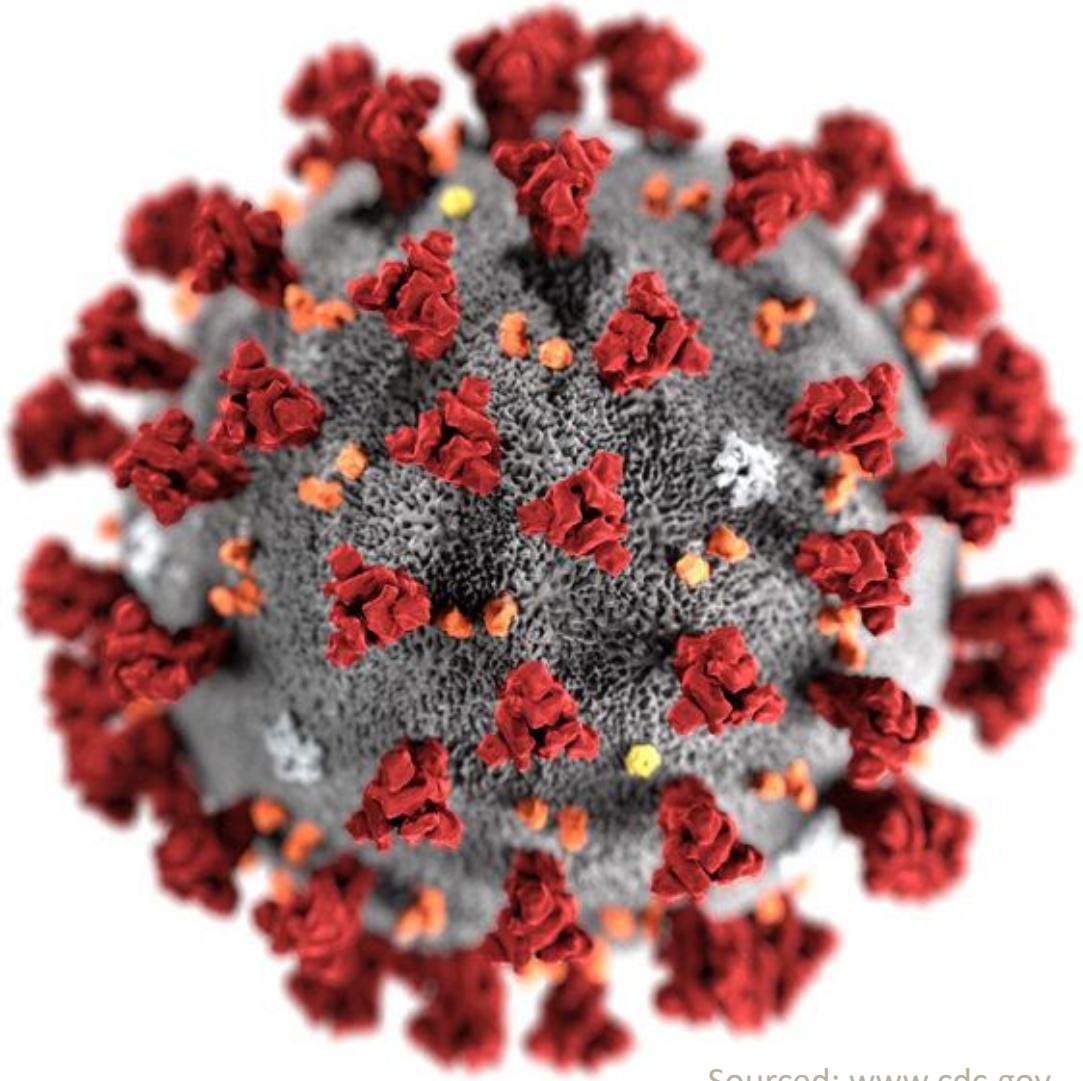
- The FAMU-FSU College of Engineering is used by thousands daily
- There are several types of spaces around the college

Sourced: eng.famu.fsu.edu, www.thebluebook.com

Razhan Matipano

COVID-19

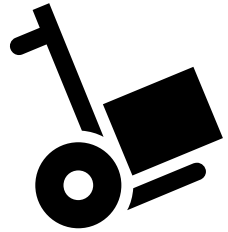
- Air quality is especially important
- Caused by the pathogen SARS-CoV-2
- Carried by respiratory droplets in air



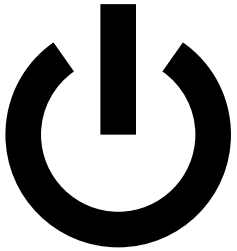
Sourced: www.cdc.gov

Razhan Matipano

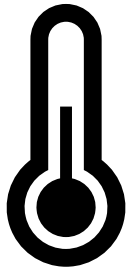
Facilities' Needs



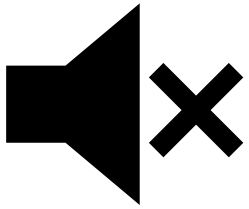
Portable



Internal
Power Source



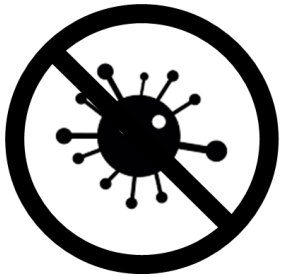
Limited
Heat



Limited
Volume

Honeywell's Needs

Monitors
Air Quality



Reduces
Contamination

Razhan Matipano

Functional Decomposition

Control System	Ventilate room	Improve Air Composition
Sense and measure air quality		

Razhan Matipano

Functional Decomposition

Control System	Ventilate room	Improve Air Composition
Control hardware  Sense and measure air quality		

Razhan Matipano

Functional Decomposition

Control System	Ventilate room	Improve Air Composition
Control hardware	Propel air through device	
Sense and measure air quality		

Razhan Matipano

Functional Decomposition

Control System

Control hardware

Sense and measure air quality

Ventilate room

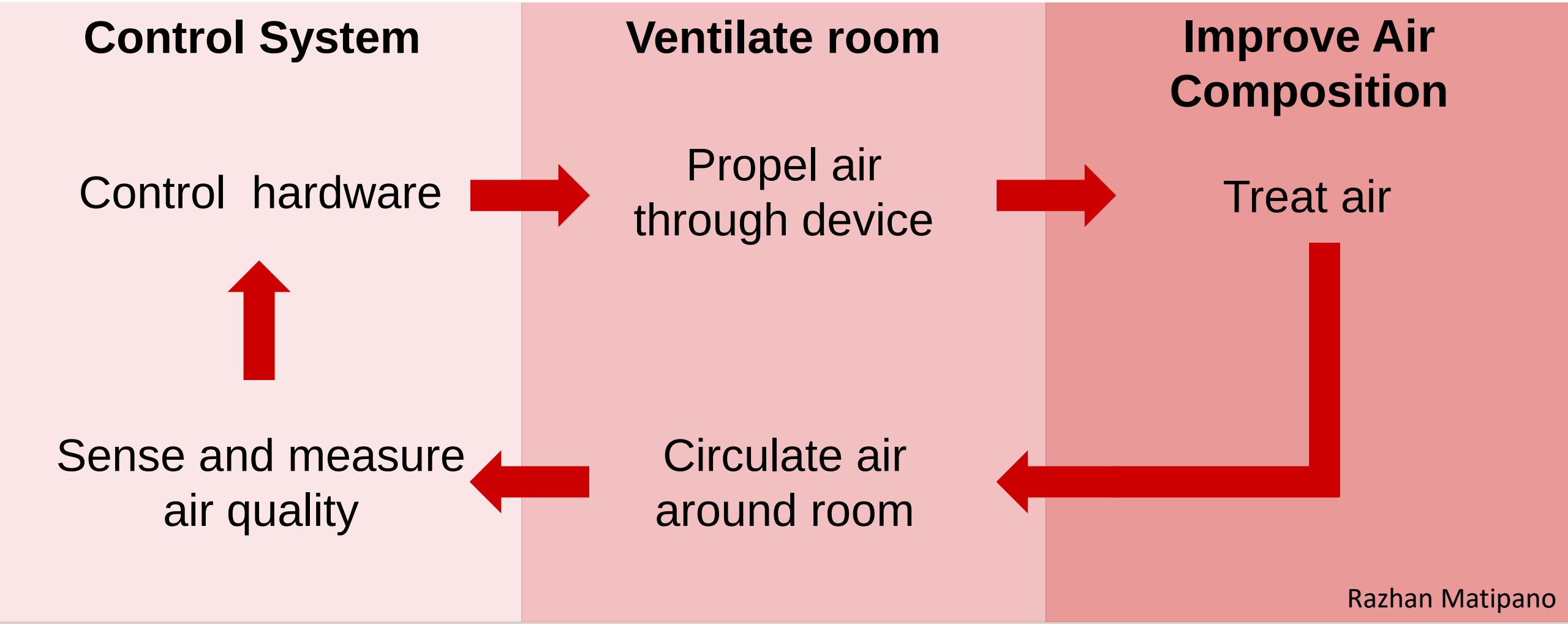
Propel air through device

Improve Air Composition

Treat air

Razhan Matipano

Functional Decomposition



Targets and Metrics

Razhan Matipano

Control System

Sense Air Quality

Concentration range of sensors

- Particulate: 0.1 µg/m^3 and 1000 µg/m^3
- Gas: 0 ppm to 250 ppm

Measure Air Quality

Accuracy of sensors

- Particulate: ±15%
- Gas: ±3%

Control Hardware

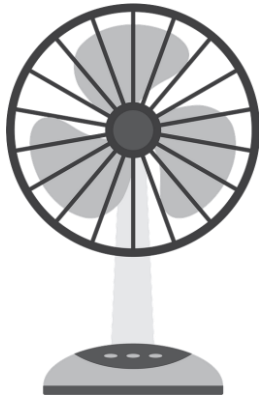
Reaction time of hardware

- 6 seconds

Sourced: Honeywell.com

Razhan Matipano

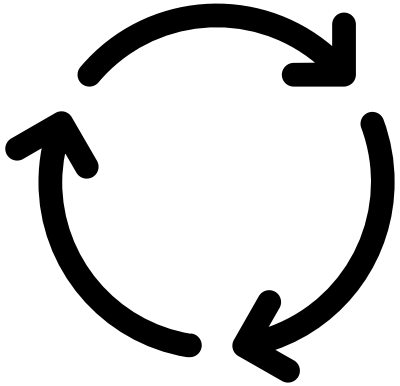
Ventilate Room



Propel Air

Volumetric flowrate per person

- 40 cfm per person



Circulate Air

Number of air changes per hour

- 7

Razhan Matipano

Improve Air Composition

Treat Air

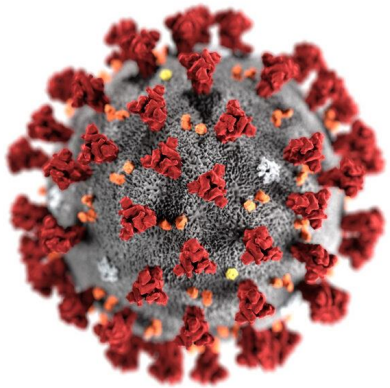
Number of Filters

- 3

Filter Particulates

Minimum diameter of filterable particles

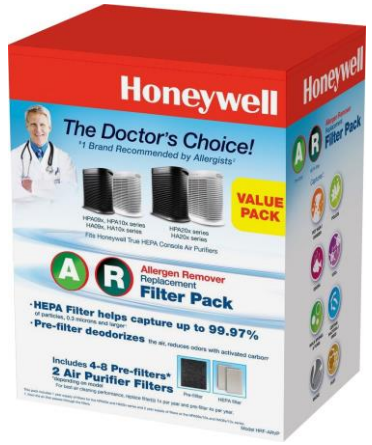
- 0.1 µm



Control Air Humidity

Humidity range

- 40% to 60%



Sanitize Contaminants

Particulate removal percentage

- 99%

Sourced: Honeywell.com, www.cdc.gov

Razhan Matipano

Methods of Validation

Inspection

Measure and Calculate

Test Equipment

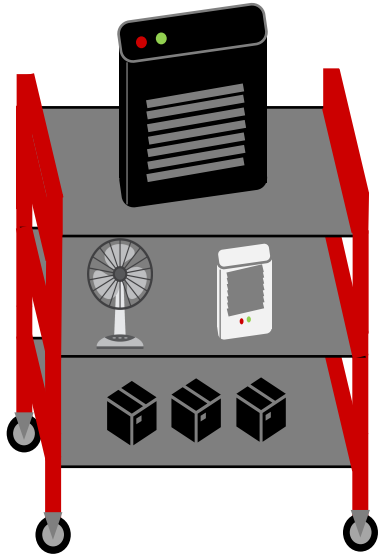
Sourced: Honeywell.com, Walmart.com

Razhan Matipano

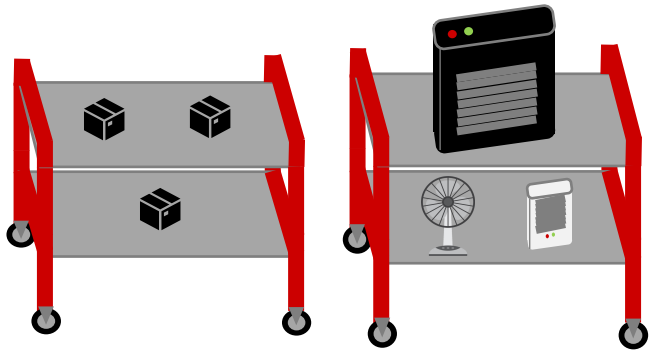
Concept Generation and Selection

Whitley Pettis

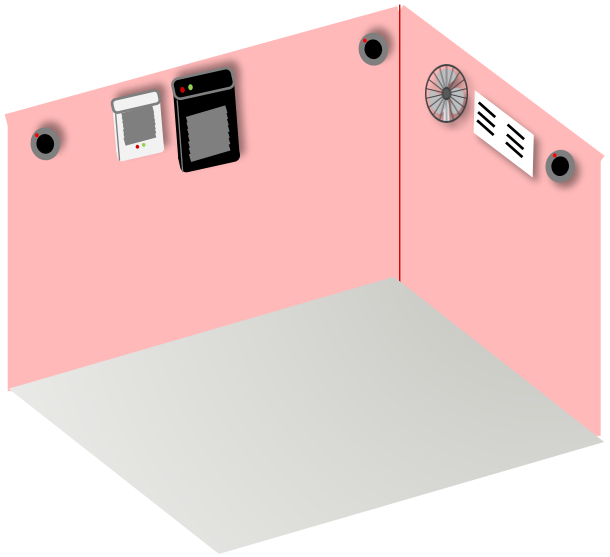
High Fidelity Concepts



Mobile Sensing and Cleaning Station



Dual Sensing and Cleaning Stations

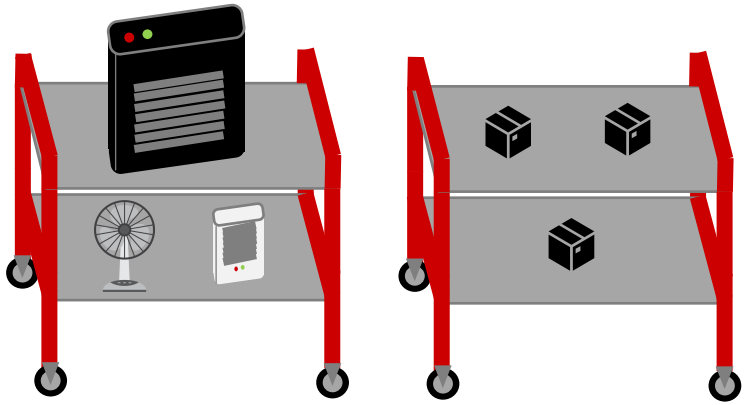


Mounted Sensing and Cleaning Devices

Whitley Pettis

Concept Selection

- House of Quality identified most important engineering characteristics:
  - Measure air quality
  - Monitor air quality
- Pugh Chart eliminated mounted sensing and cleaning devices
- Analytic Hierarchy Process used to select dual sensing and cleaning stations as final design



Whitley Pettis

Bill of Materials

Whitley Pettis

Storage and Power

120 V Power Station

Utility Cart

Sourced: Honeywell.com, APC.com

Whitley Pettis

Sensing

Anemometer

HPM Particulate Matter Sensor

Multi-Gas Detector

Humidity Monitor

Sourced: Honeywell.com, Grainger

Whitley Pettis

Sensing

Intellidox
Docking Station

ComfortPoint
Controller

Mobile
Computer

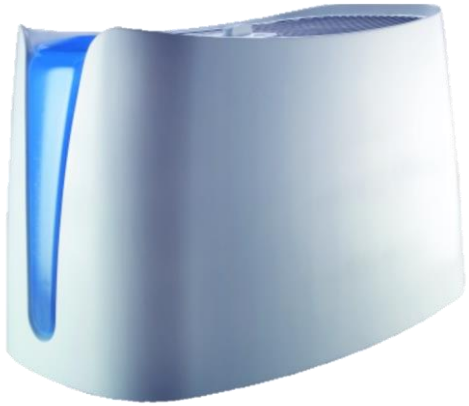
Sourced: Honeywell.com

Whitley Pettis

Cleaning

Dual UV Sanitizing Lamp

HEPA Air Purifier



Humidifier

Dehumidifier

TurboForce Floor Fan

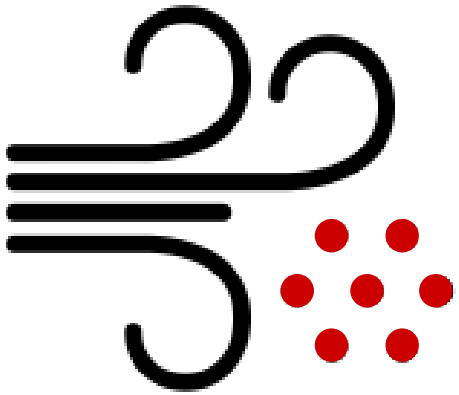
Sourced: Honeywell.com

Whitley Pettis

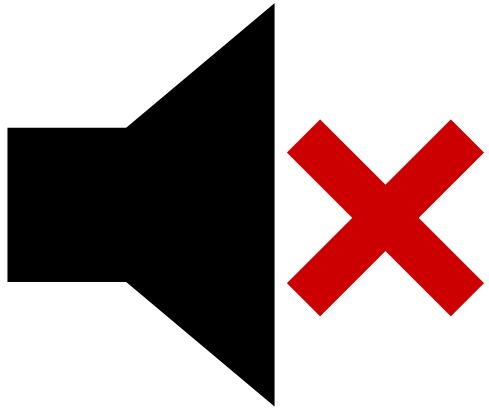
Testing

Whitley Pettis

Preliminary Tests



Measure air quality before cleaning

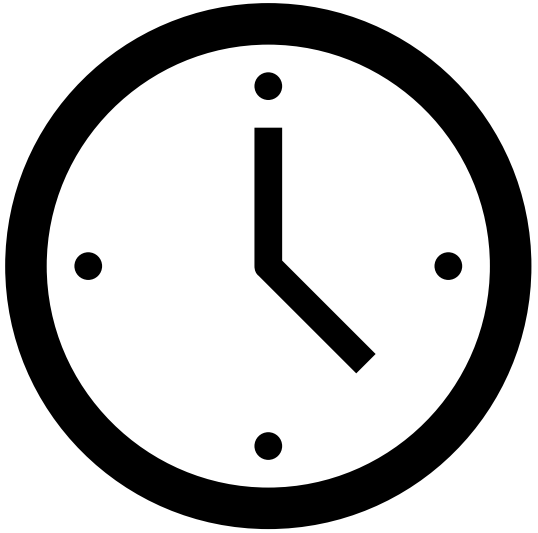


Measure equipment noise levels before placement

Whitley Pettis

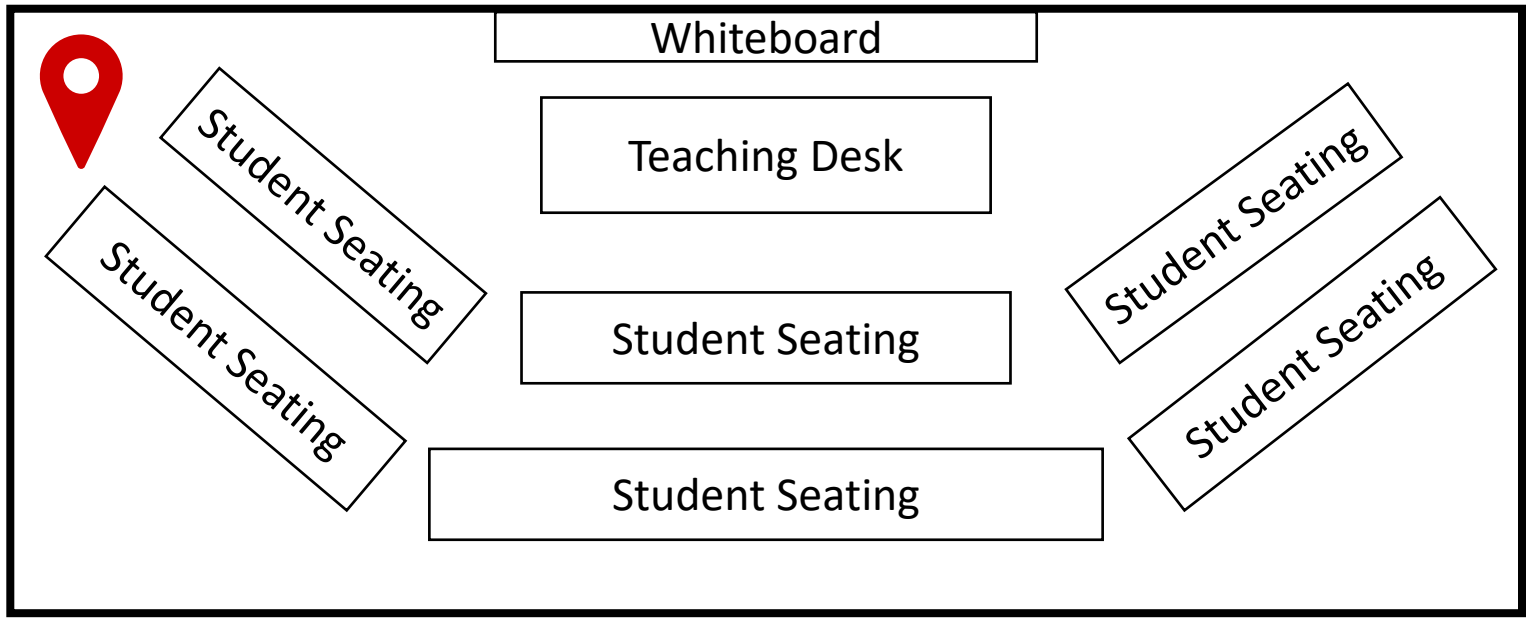
Testing Procedures

- Measure air quality in the same location at different times of day
- Track any changes and note corresponding times
- Attempt to relate changes in air quality to specific activities:
  - Class meetings
  - Lab experiments
  - Equipment usage



Whitley Pettis

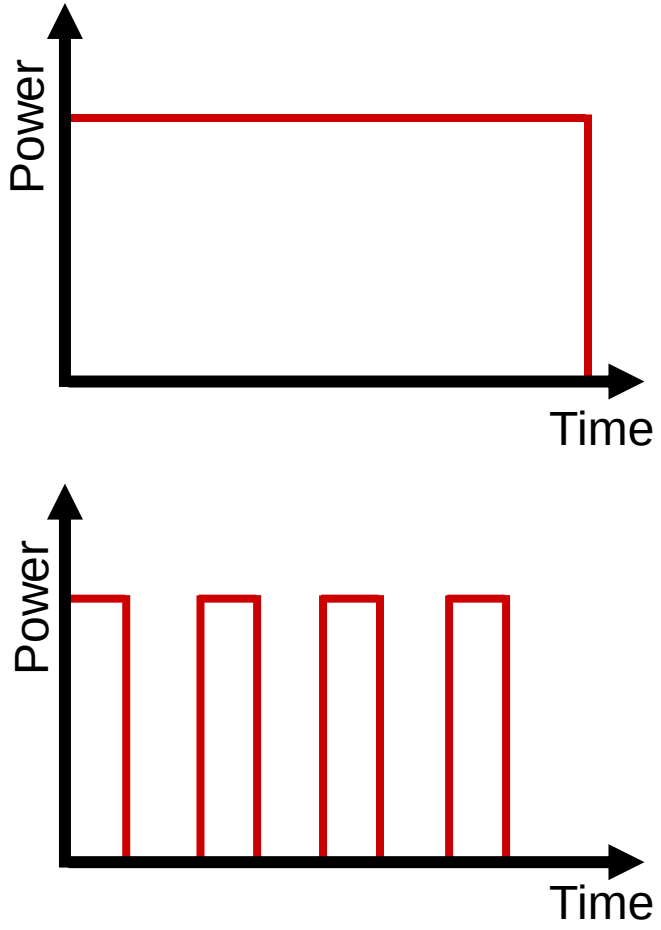
Testing Procedures



- Move cleaning equipment to different locations in the same room
- Monitor whether certain locations are more effective for improving the room's air quality

Whitley Pettis

Testing Procedures



- Run cleaning equipment constantly then intermittently in the same location
- Compare recorded air quality from the tests
- Use results to find the balance between energy consumption and cleaning efficiency

Whitley Pettis

Future work

Whitley Pettis

Key Takeaways

- Materials needed to complete the project have been selected and are in the process of being ordered
- Tests to validate the design have been planned and will be carried out in the coming weeks

Whitley Pettis

References

Blueair. (n.d.). *Pro M*. Retrieved from blueair: https://www.blueair.com/us/pro/pro-m/1408.html?cgid=pro

Environamental Protection Agency . (1990, July). *Ventilation and Air Quality in Offices.* Retrieved from https://www.epa.gov/sites/production/files/2014-08/documents/ventilation_factsheet.pdf

Environmental Protection Agency. (1989). *Report to Congress on Indoor Air Quality.*

Falke, R. (2016, March 24). *Use the Air Changes Calculation to Determine Room CFM*. Retrieved from Contracting Business : https://www.contractingbusiness.com/service/article/20868246/use-the-air-changes-calculation-to-determine-room-cfm

Honeywell . (n.d.). *Honeywell Filter A Universal Carbon Pre-Filter, HRF-AP1 (Replaces 38002)*. Retrieved from Honeywell Store: https://www.honeywellstore.com/store/products/honeywell-universal-carbon-pre-filter-hrf-ap1.htm

Honeywell. (2012, November). *E3 Point Specifications.* Retrieved from https://www.instrumart.com/assets/Honeywell-e3point-standalone2-datasheet.pdf

Honeywell. (2019, May). *HPM Series Particulate Matter Sensors.* Retrieved from https://sensing.honeywell.com/honeywell-sensing-particulate-hpm-series-datasheet-32322550.pdf

Honeywell. (n.d.). *Honeywell True HEPA Whole Room Air Purifier With Allergen Remover, HPA300*. Retrieved from Honeywell Store: https://www.honeywellstore.com/store/products/hpa300-true-hepa-whole-room-air-purifier-with-allergen-remover.htm?gclid=Cj0KCQjwit_8BRCoARIsAIx3Rj4begs_A3wW7Kjc6ktbr_sgMQfBrl0BI7Z_4R-9y6KaVkuL60M_dTUaAmQUEALw_wcB

Blueair. (n.d.). *Pro M*. Retrieved from blueair: https://www.blueair.com/us/pro/pro-m/1408.html?cgid=pro

Environamental Protection Agency . (1990, July). *Ventilation and Air Quality in Offices.* Retrieved from https://www.epa.gov/sites/production/files/2014-08/documents/ventilation_factsheet.pdf

Environmental Protection Agency. (1989). *Report to Congress on Indoor Air Quality.*

Falke, R. (2016, March 24). *Use the Air Changes Calculation to Determine Room CFM*. Retrieved from Contracting Business : https://www.contractingbusiness.com/service/article/20868246/use-the-air-changes-calculation-to-determine-room-cfm

Whitley Pettis

References

Honeywell . (n.d.). *Honeywell Filter A Universal Carbon Pre-Filter, HRF-AP1 (Replaces 38002)*. Retrieved from Honeywell Store: https://www.honeywellstore.com/store/products/honeywell-universal-carbon-pre-filter-hrf-ap1.htm

Honeywell. (2012, November). *E3 Point Specifications.* Retrieved from https://www.instrumart.com/assets/Honeywell-e3point-standalone2-datasheet.pdf

Honeywell. (2019, May). *HPM Series Particulate Matter Sensors.* Retrieved from https://sensing.honeywell.com/honeywell-sensing-particulate-hpm-series-datasheet-32322550.pdf

Honeywell. (n.d.). *Honeywell True HEPA Whole Room Air Purifier With Allergen Remover, HPA300*. Retrieved from Honeywell Store: https://www.honeywellstore.com/store/products/hpa300-true-hepa-whole-room-air-purifier-with-allergen-remover.htm?gclid=Cj0KCQjwit_8BRCoARIsAIx3Rj4begs_A3wW7Kjc6ktbr_sgMQfBrl0BI7Z_4R-9y6KaVkuL60M_dTUaAmQUEALw_wcB

M. Jeremiah Matson, C. K.-S. (2020). Effect of Environmental Conditions on SARS-CoV-2 Stability in Human Nasal Mucus and Sputum. *Emerging Infectious Diseases*.

Moreno, T., & de Miguel, E. (2018). Improving air quality in subway systems: An overview. *Environmental Pollution* , 829-831.

Sylvane. (n.d.). *Frequently Asked Questions About Air Purifiers*. Retrieved from Sylvane: https://www.sylvane.com/air-purifier-faq.html#:~:text=High%20Efficiency%20Particulate%20Air%20(HEPA,and%20pollen%20from%20your%20air

Texas Instruments . (2016, May). *PM2.5/PM10 Particle Sensor Analog Front-End for Air.* Retrieved from https://www.ti.com/lit/ug/tidub65c/tidub65c.pdf

Texas Instruments. (2020, 10 30). *PM2.5/PM10 Particle Sensor Analog Front-End for Air.* Retrieved from https://www.ti.com/lit/ug/tidub65c/tidub65c.pdf

Uline. (n.d.). *Uline 3-Shelf Utility Cart with Flat Shelves - 27 x 18 x 34", Black*. Retrieved from Uline: https://www.uline.com/Product/Detail/H-5007BL/Utility-Carts/Uline-3-Shelf-Utility-Cart-with-Flat-Shelves-27-x-18-x-34-Black?pricode=WA9800&gadtype=pla&id=H-5007BL&gclid=Cj0KCQjwxNT8BRD9ARIsAJ8S5xZs2sqeNe-FNcf0eXoP6YRdOigzw7Grd-wCJlI4rb0sTgOXVDB29_waApxfEA

World Health Organization . (n.d.). *Common Noise*. Retrieved from https://www.who.int/docstore/peh/noise/Comnoise-4.pdf

Whitley Pettis

Backup Slides

	Major functions		
Minor functions	Control System	Ventilate Room	Improve Air Composition
Sense Air Quality	x		
Measure Air Quality	x		
Activate Propeller	x		
Deactivate Propeller	x		
Modulate Propeller	x		
Activate Purifier	x		
Deactivate Purifier	x		
Modulate Purifier	x		
Propel Air		x	
Circulate Air		x	x
Purify Air			x
Treat Air			x
Filter Particulates			x
Dehumidify Air			x
Humidify Air			x
Sanitize Contaminants			x
Total	8	2	7

Questions	Customer Statement	Interpreted Need
Would using the most outside air be efficient enough to clean air?	The best method to clean the air, would be 100% outside air utilization. This would be too expensive	Clean and recycle existing indoor air.
How do healthy buildings affect energy consumption?	Using systems to work more efficiently, increases consumption. Portable and battery powered units with data loggers.	A device that is portable and battery powered would be more appropriate.
Are there any structural or sizing limitations? e.g. volume, height, length, weight, etc.	The device cannot be added to the existing structure of mechanical equipment. Small, and lightweight to be moved on a cart.	A portable device that can be moved easily.
In what environment will the project be used? e.g. home, office, stadium, retail, etc.	The idea is to create a product that can be used at FAMU-FSU COE	The product is designed to work in classrooms, labs, and study spaces.
Should it be geared towards reducing contamination or increasing ventilation?	The device should be geared towards reducing contaminants.	The product reduces contamination and increases ventilation.

Do you have any existing products or previous research that could be used to help this project?	Similar projects are being done at other universities.	The product will resemble other products that have been installed in other universities.
Will our project be used in conjunction with an existing product or will an entirely new system need to be designed?	Since we have products already made, I do not figure that you all will create an entirely new system.	The product will work in conjunction with an existing product.
If it will be used in conjunction with another system, what type of system? Do you have any specific details?	We will donate products for you to work with.	The project will make use of existing Honeywell products.
Does the current COE mechanical system include sensors?	Some rooms have humidity sensors, but there are no Volatile Organic Compounds (VOC) or particulate sensors.	Device will measure the VOC, CO2, humidity, temperature, and particulate levels
Is there a problem with the current purifiers?	Current purifiers would only clean 10% of the air in the room, because of placement.	The device will clean and monitor more of the air in the spaces.
What is the nature of the contamination we are aiming to reduce? e.g. viruses, bacteria, fungi, odor, etc.	Reducing the replication of airborne pathogens	The product reduces viruses that are in the hotspot area.
Does the project need to be an automatic or a manual system?	It would be great for it to be automatic but if it ends up having to be manual that will work.	The product is activated automatically.

	Monitor Air Quality	Portable	No Noise	No Heat	Reduces Contamination	Internal Power Source	Compatiable with Honeywell Products	Doesn't Interfere with Existing Infrastructure	Total
Monitor Air Quality	-	1	1	1	1	1	1	1	**7**
Portable		-	1	1					**2**
No Noise			-	1		1			**2**
No Heat				-					**0**
Reduces Contamination		1	1	1	-	1	1	1	**6**
Internal Power Source		1		1		-			**2**
Compatiable with Honeywell Products		1	1	1		1	-		**4**
Doesn't Interfere with Existing Infrastructure		1	1	1		1	1	-	**5**

		Engineering Characteristics							
Improvement		↑		↑	↓	↓	↓	↓	↓
Units		µg/m3		ft3/min	dBA	Watts	ft3	sec	µm
Customer Requirements	**Importance Weight Factor**	**Concentration Range of Sensors**	**Accuracy of Sensors**	**Volumetric Flowrate**	**Noise Level**	**Daily Energy Consumption**	**Volume of Device**	**Reaction Time of Hardware Components**	**Minimum Diameter of Particles the Device Will Filter**
Monitor Air Quality	**7**	9	9					3	
Portable	**2**					1	9		
No Noise	**2**			1	9				
No Heat	**0**								
Reduces Contamination	**6**	3	9	9				3	9
Internal Power Source	**2**					3	1		
Compatiable with Honeywell Products	**4**	1	1						
Doesn't Interfere with Existing Infrastructure	**5**						1		
Raw Score (406)		85	121	56	18	8	25	39	54
Relative Weight %		20.94	29.80	13.79	4.43	1.97	6.16	9.61	13.30
Rank Order		2	1	3	7	8	6	5	4

Pugh Chart									
Engineering Characterisitcs	Datum: Air Purifier	Concept 13: Single mobile cart	Concept 14: double mobile cart	Concept 34: Air purifier on cart	Concept 36: Stationary air purifier	Concept 38: Air purifier with UV cleaning	Concept 46: rotating air furifier	Concept 47: Light-up air purifier	Concept 48: Wall mounted sensors
ability to circulate air	Datum	+	S	+	+	S	S	-	+
ability to purify air		+	+	S	+	+	+	+	S
ability to filter particulates		+	+	+	+	S	S	+	S
ability to humidify and dehumidify air		+	+	+	+	-	-	-	+
utilizes control systems		+	+	+	-	-	-	S	+
portable		S	+	+	-	-	-	+	-
utilizes proprietary power source		S	S	S	-	-	-	S	+
utilizes multiple sensors		S	S	-	-	-	-	+	S
Plusses		5	5	5	4	1	1	4	4
Minuses		0	0	1	4	5	5	2	1
Satisfactory		3	3	2	0	2	2	2	3

Pugh Chart				
Engineering Characterisitcs	Concept 34: Air purifier on cart	Concept 13: Single mobile cart	Concept 14: double mobile cart	Concept 48: wall mounted sensors
Ability to circulate air	Datum	+	S	S
ability to purify air		+	+	+
ability to filter particulates		+	+	+
ability to humidify and dehumidify air		+	+	+
utilizes control systems		S	S	+
utilizes mobility		S	+	-
utilizes proprietary power source		S	S	-
utilizes multiple sensors		S	S	S
Plusses		4	4	4
Minuses		0	0	2
Satisfactory		4	4	2

Development of Candidate Set of Criteria Weights {W}												
Criteria Comparison Matrix [C]												
Engineering Characteristics	**Portability**	**Sense air Quality**	**Propeller Activation**	**Propeller Modulation**	**Purifier Activation**	**Purifier Modulation**	**Air Propulsion**	**Air Purification**	**Air Treatment**	**Filter Particulates**	**Humidify**	**Sanitize**
Portability	1.00	3.00	0.14	0.14	0.14	0.14	0.20	0.20	0.20	0.20	0.20	3.00
Sense air Quality	0.33	1.00	0.14	0.20	0.20	0.20	0.20	0.14	0.14	0.14	0.33	5.00
Propeller Activation	7.00	5.00	1.00	7.00	1.00	3.00	0.33	0.14	0.14	0.14	0.20	0.14
Propeller Modulation	7.00	5.00	0.14	1.00	0.14	1.00	0.33	0.14	0.14	0.14	0.20	0.14
Purifier Activation	7.00	5.00	1.00	7.00	1.00	5.00	0.33	0.14	0.20	0.20	0.20	0.14
Purifier Modulation	7.00	5.00	0.33	1.00	0.20	1.00	0.33	0.20	0.20	0.20	0.20	0.20
Air Propulsion	5.00	5.00	3.00	3.00	3.00	3.00	1.00	0.33	0.33	0.20	0.20	0.33
Air Purification	5.00	7.00	7.00	7.00	7.00	5.00	3.00	1.00	1.00	0.33	0.20	0.33
Air Treatment	5.00	7.00	7.00	7.00	5.00	5.00	3.00	1.00	1.00	0.33	3.00	3.00
Filter Particulates	5.00	7.00	7.00	7.00	5.00	5.00	5.00	3.00	3.00	1.00	5.00	5.00
Humidify	5.00	3.00	5.00	5.00	5.00	5.00	5.00	5.00	0.33	0.20	1.00	1.00
Sanitize	0.33	0.20	7.00	7.00	7.00	5.00	3.00	3.00	0.33	0.20	1.00	1.00
Sum	54.67	53.20	38.76	52.34	34.69	38.34	21.73	14.30	7.03	3.30	11.73	19.30

Development of Candidate Set of Criteria Weights {W}													
Normalized Criteria Comparison Matrix [NormC]													
Engineering Characteristics	Portability	Sense air Quality	Propeller Activation	Propeller Modulation	Purifier Activation	Purifier Modulation	Air Propulsion	Air Purification	Air Treatment	Filter Particulates	Humidify	Sanitize	Criteria Weight {W}
Portability	0.0183	0.0564	0.0037	0.0027	0.0041	0.0037	0.0092	0.0140	0.0284	0.0606	0.0171	0.1554	0.0311
Sense air Quality	0.0061	0.0188	0.0037	0.0038	0.0058	0.0052	0.0092	0.0100	0.0203	0.0433	0.0284	0.2591	0.0345
Propeller Activation	0.1280	0.0940	0.0258	0.1337	0.0288	0.0782	0.0153	0.0100	0.0203	0.0433	0.0171	0.0074	0.0502
Propeller Modulation	0.1280	0.0940	0.0037	0.0191	0.0041	0.0261	0.0153	0.0100	0.0203	0.0433	0.0171	0.0074	0.0324
Purifier Activation	0.1280	0.0940	0.0258	0.1337	0.0288	0.1304	0.0153	0.0100	0.0284	0.0606	0.0171	0.0074	0.0566
Purifier Modulation	0.1280	0.0940	0.0086	0.0191	0.0058	0.0261	0.0153	0.0140	0.0284	0.0606	0.0171	0.0104	0.0356
Air Propulsion	0.0915	0.0940	0.0774	0.0573	0.0865	0.0782	0.0460	0.0233	0.0474	0.0606	0.0171	0.0173	0.0580
Air Purification	0.0915	0.1316	0.1806	0.1337	0.2018	0.1304	0.1381	0.0699	0.1422	0.1010	0.0171	0.0173	0.1129
Air Treatment	0.0915	0.1316	0.1806	0.1337	0.1441	0.1304	0.1381	0.0699	0.1422	0.1010	0.2558	0.1554	0.1395
Filter Particulates	0.0915	0.1316	0.1806	0.1337	0.1441	0.1304	0.2301	0.2098	0.4267	0.3030	0.4263	0.2591	0.2222
Humidify	0.0915	0.0564	0.1290	0.0955	0.1441	0.1304	0.2301	0.3497	0.0474	0.0606	0.0853	0.0518	0.1226
Sanitize	0.0061	0.0038	0.1806	0.1337	0.2018	0.1304	0.1381	0.2098	0.0474	0.0606	0.0853	0.0518	0.1041
Sum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Development of Weighted Sum Vectors {Ws}													
Engineering Characteristics	**Portability**	**Sense air Quality**	**Propeller Activation**	**Propeller Modulation**	**Purifier Activation**	**Purifier Modulation**	**Air Propulsion**	**Air Purification**	**Air Treatment**	**Filter Particulates**	**Air Humidification**	**Sanitize Contaminants**	**Weighted Sum {Ws}**
Portability	0.0311	0.1034	0.0072	0.0046	0.0081	0.0051	0.0116	0.0226	0.0279	0.0444	0.0245	0.0312	0.3218
Sense air Quality	0.0104	0.0345	0.0072	0.0065	0.0113	0.0071	0.0116	0.0161	0.0199	0.0317	0.0409	0.0521	0.2493
Propeller Activation	0.2177	0.1724	0.0502	0.2266	0.0566	0.1068	0.0194	0.0161	0.0199	0.0317	0.0245	0.0015	0.9435
Propeller Modulation	0.2177	0.1724	0.0072	0.0324	0.0081	0.0356	0.0194	0.0161	0.0199	0.0317	0.0245	0.0015	0.5865
Purifier Activation	0.2177	0.1724	0.0502	0.2266	0.0566	0.1781	0.0194	0.0161	0.0279	0.0444	0.0245	0.0015	1.0354
Purifier Modulation	0.2177	0.1724	0.0167	0.0324	0.0113	0.0356	0.0194	0.0226	0.0279	0.0444	0.0245	0.0021	0.6270
Air Propulsion	0.1555	0.1724	0.1506	0.0971	0.1699	0.1068	0.0581	0.0376	0.0465	0.0444	0.0245	0.0035	1.0670
Air Purification	0.1555	0.2413	0.3514	0.2266	0.3965	0.1781	0.1742	0.1129	0.1395	0.0741	0.0245	0.0035	2.0780
Air Treatment	0.1555	0.2413	0.3514	0.2266	0.2832	0.1781	0.1742	0.1129	0.1395	0.0741	0.3680	0.0312	2.3359
Filter Particulates	0.1555	0.2413	0.3514	0.2266	0.2832	0.1781	0.2903	0.3388	0.4186	0.2222	0.6133	0.0521	3.3712
Air Humidification	0.1555	0.1034	0.2510	0.1619	0.2832	0.1781	0.2903	0.5647	0.0465	0.0444	0.1227	0.0104	2.2119
Sanitize Contaminants	0.0104	0.0069	0.3514	0.2266	0.3965	0.1781	0.1742	0.3388	0.0465	0.0444	0.1227	0.0104	1.9067
Sum	1.70	1.83	1.95	1.69	1.96	1.37	1.26	1.62	0.98	0.73	1.44	0.20	16.73

Function	Part Number	Part Name	Vendor	Part Model Number	Weight (lbs)	Dimensions (inches)	Unit Cost	Number of Units	Cost
storage	1	3-Shelf Utility Cart	Uline	H-5007BL	46	44 x 25 x 33	$ 125.00	2	$ 250.00
sensing	2	HPM Series PM2.5 Particulate Matter Sensor	Honeywell	HPMA115C0-XXX	N/A	1.7 x 1.4 x 0.9	$ 42.01	1	$ 42.01
	3	BW Ultra Multi-Gas Detector	Honeywell	DS01195	0.9	5.8 x 3.3 x 1.6	$ 2,515.00	1	$2,515.00
	4	IntelliDox Docking Station	Honeywell	DS20151112	4.2	5.4 x 14.3 x 4.3	$ 1,890.14	1	$1,890.14
	5	Honeywell Humidity Monitor With Digital Display	Honeywell	HHM10	0.14	3.54 x 1.18 x 3.1	$14.95	1	$ 14.95
	6	Anemometer	Grainger	AN100-NIST	1.6	7 x 2.9 x 1.3	$ 342.00	1	$ 342.00
	7	Dual UV Lamp	Honeywell	UV100E2009	N/A	19 x 15 x 8.5	$ 446.04	1	$ 446.04
	8	ComfortPoint Open Controller	Honeywell	CPO-PC400	N/A	5.7 x 4.3 x 2.3	By Quote Only	1	N/A
	9	CT60 Mobile Computer	Honeywell	CT60	0.77	6.3 x 3.2 x 0.7	$ 2,050.00	1	$2,050.00
cleaning	10	Honeywell Professional Series True HEPA Air Purifier	Honeywell	HPA600B	32	16.73 x 9.45 x 24.25	$ 699.99	1	$ 699.99
	11	Honeywell TurboForce Floor Fan	Honeywell	HF-910	8.58	23.8 x 6.8 x 22.9	$ 49.45	1	$ 49.45
	12	Honeywell 70-Pint Energy Star Dehumidifier	Honeywell	TP70PWKN	43.6	15.7 x 12.4 x 25.4	$ 374.95	1	$ 374.95
	13	Honeywell UV Cool Moisture Germ Free Humidifier	Honeywell	HCM-350	8.36	17.5 x 9.4 x 11.9	$ 69.95	1	$ 69.95
Power	14	APC Back-UPS	APC	BE850M2	9.04	5.5 x 12.9 x 4.1	$ 113.99	1	$ 113.99
								Total Cost	$8,858.47