Team 510: Indoor Air Quality of Hotspots

April 8th 2021

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

Team Introductions

Eric Grogans
Electrical Engineer

Leon Johnson
Test Engineer

Emma Martin
Project Engineer

Razhan Matipano
Research Engineer

Whitley Pettis
Manufacturing Engineer

Whitley Pettis

Sponsor and Advisor

FAMU-FSU College of Engineering

Honeywell

<u>Engineering Mentor</u>
Alfred Guerrero
Honeywell

<u>Engineering Mentor</u>
Danny White
Honeywell

<u>Engineering Mentor</u>
Danny Mims
Honeywell

<u>Academic Advisor</u>
Neda Yaghoobian, Ph.D.
Professor

<u>Senior Design Professor</u>
Dr. McConomy, Ph.D.
Professor

Whitley Pettis

Objective

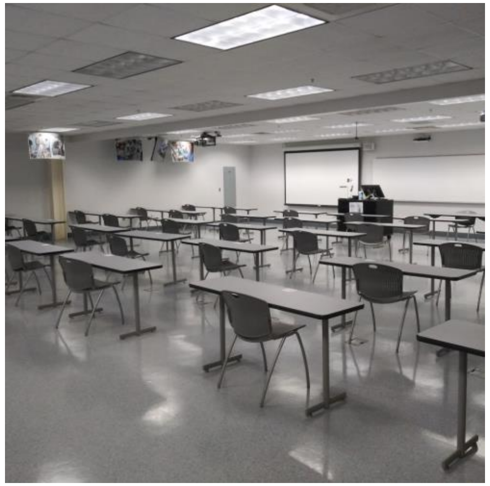
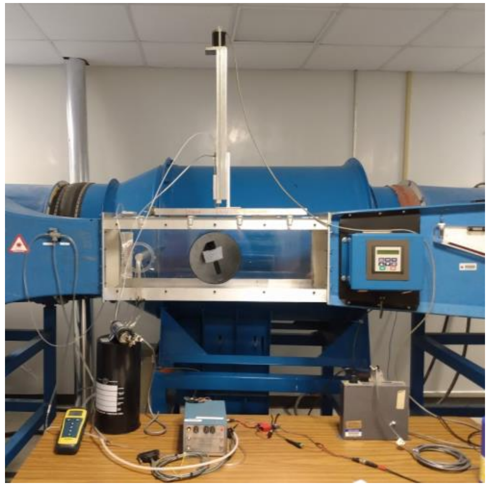
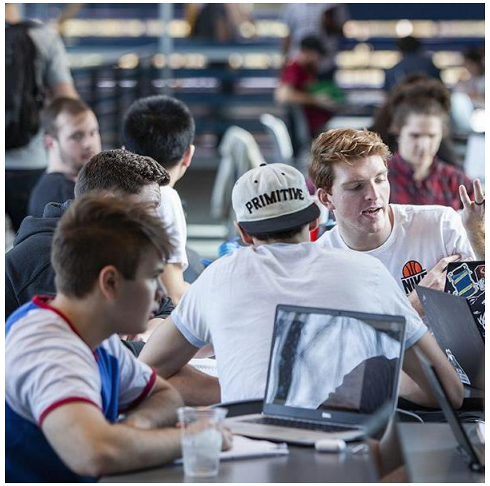
The objective of this project is to measure and modify air quality in the FAMU-FSU College of Engineering to promote a healthy building environment.

Whitley Pettis

Project Background

Whitley Pettis

Location

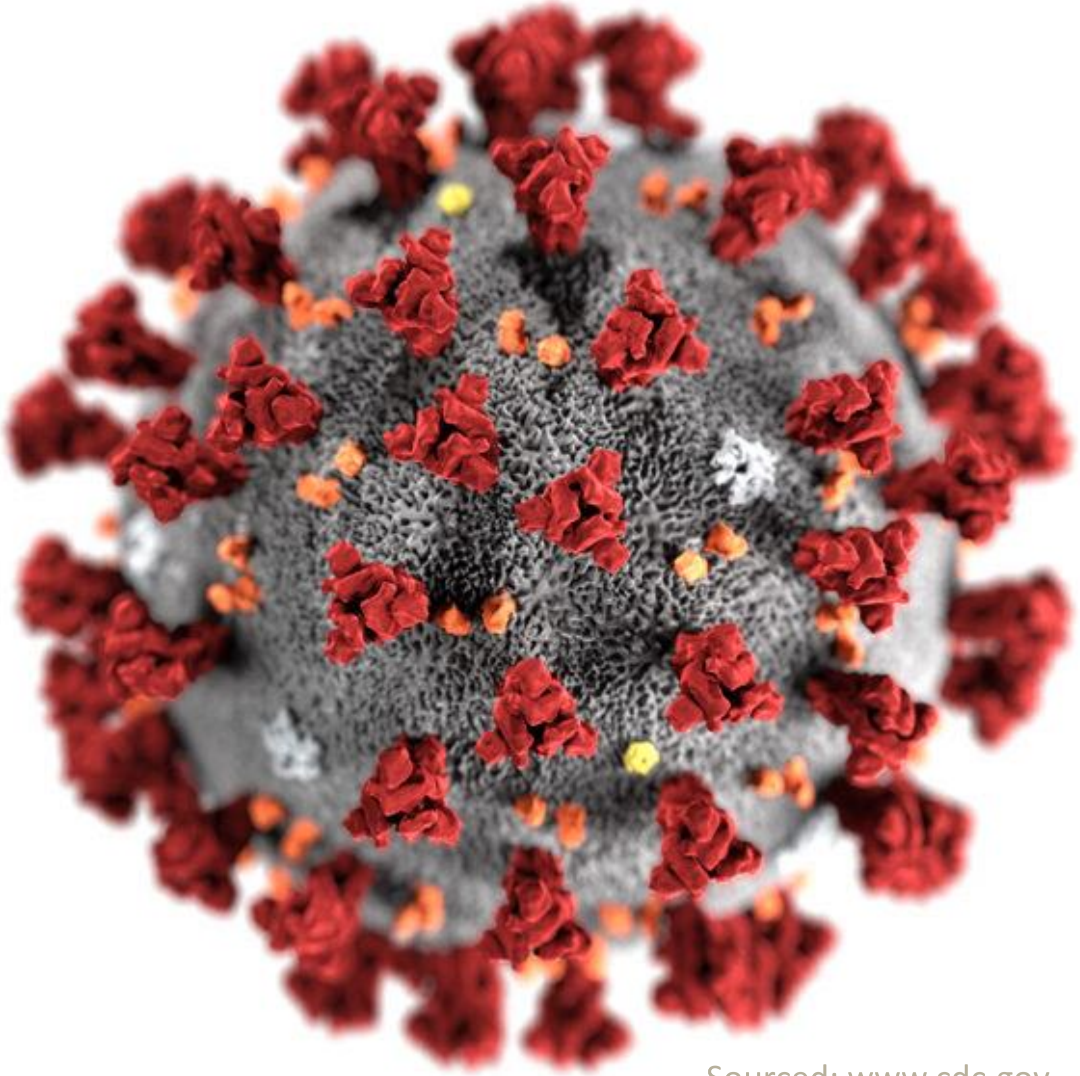

- The FAMU-FSU College of Engineering is used by thousands daily
- There are several types of spaces around the college

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

Whitley Pettis

COVID-19

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



Sourced: www.cdc.gov

Whitley Pettis

Facilities' Needs

Portable

Internal Power Source

Limited Heat

Limited Volume

Honeywell's Needs

Monitors Air Quality

Reduces Contamination

Whitley Pettis

Functional Decomposition

Control System	Ventilate room	Improve Air Composition

Whitley Pettis

Functional Decomposition

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

Whitley Pettis

Functional Decomposition

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

Whitley Pettis

Functional Decomposition

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

Whitley Pettis

Functional Decomposition

Control System

Control hardware

Sense and measure air quality

Ventilate room

Propel air through device

Improve Air Composition

Treat air

Whitley Pettis

Functional Decomposition

Control System	Ventilate room	Improve Air Composition
Control hardware →	Propel air through device →	Treat air
↑		↓
Sense and measure air quality	← Circulate air around room	←

Whitley Pettis

Targets and Metrics

Emma Martin

Control System

Sense Air Quality
Concentration range of sensors
- Particulate: 0.1 µg/m³ and 1000 µg/m³
- Gas: 0 ppm to 250 ppm

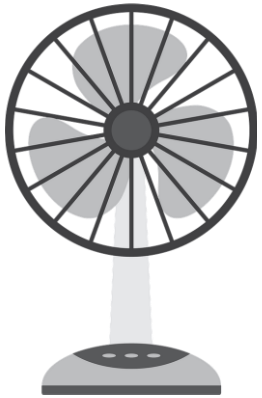
Measure Air Quality
Accuracy of sensors
- Particulate: ±15%
- Gas: ±3%

Control Hardware
Reaction time of hardware
- 6 seconds

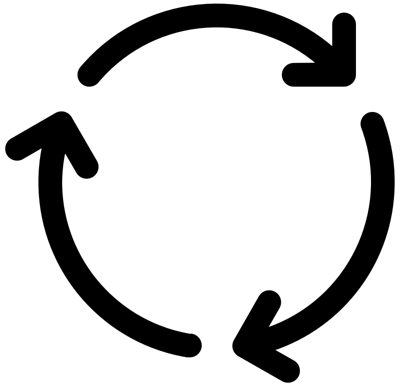
Sourced: Honeywell.com

Emma Martin

Ventilate Room



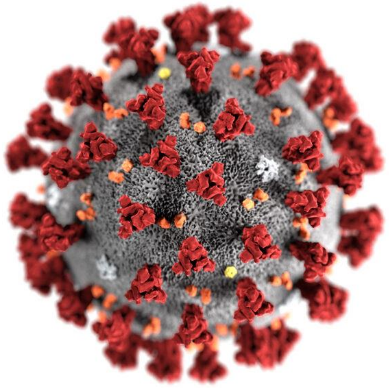
Propel Air
Volumetric flowrate per person
- 40 cfm per person



Circulate Air
Number of air changes per hour
- 7

Emma Martin

Improve Air Composition



Control Air Humidity

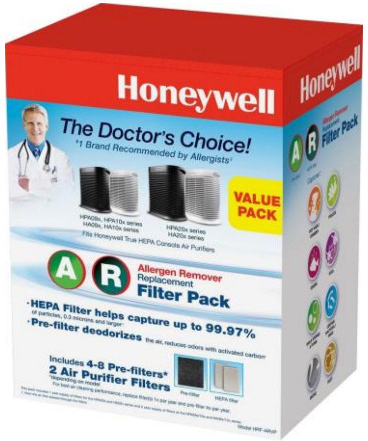
Humidity range

- 40% to 60%

Treat Air

Number of Filters

- 3



Sanitize Contaminants

Particulate removal percentage

- 99%

Filter Particulates

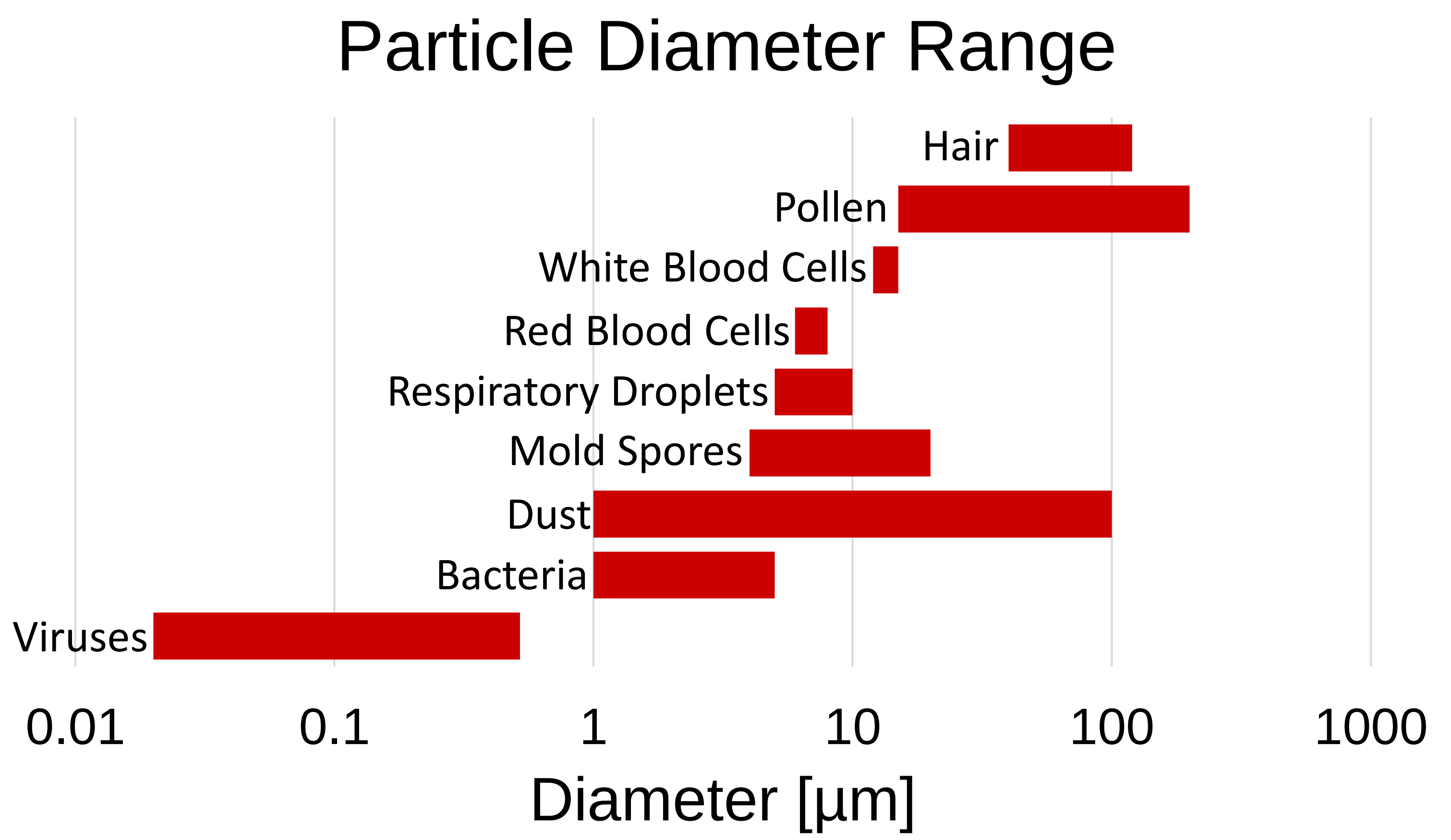
Minimum diameter of filterable particles

- 0.1 µm

Sourced: Honeywell.com, www.cdc.gov

Emma Martin

Improve Air Composition



Filter Particulates

Minimum diameter of filterable particles

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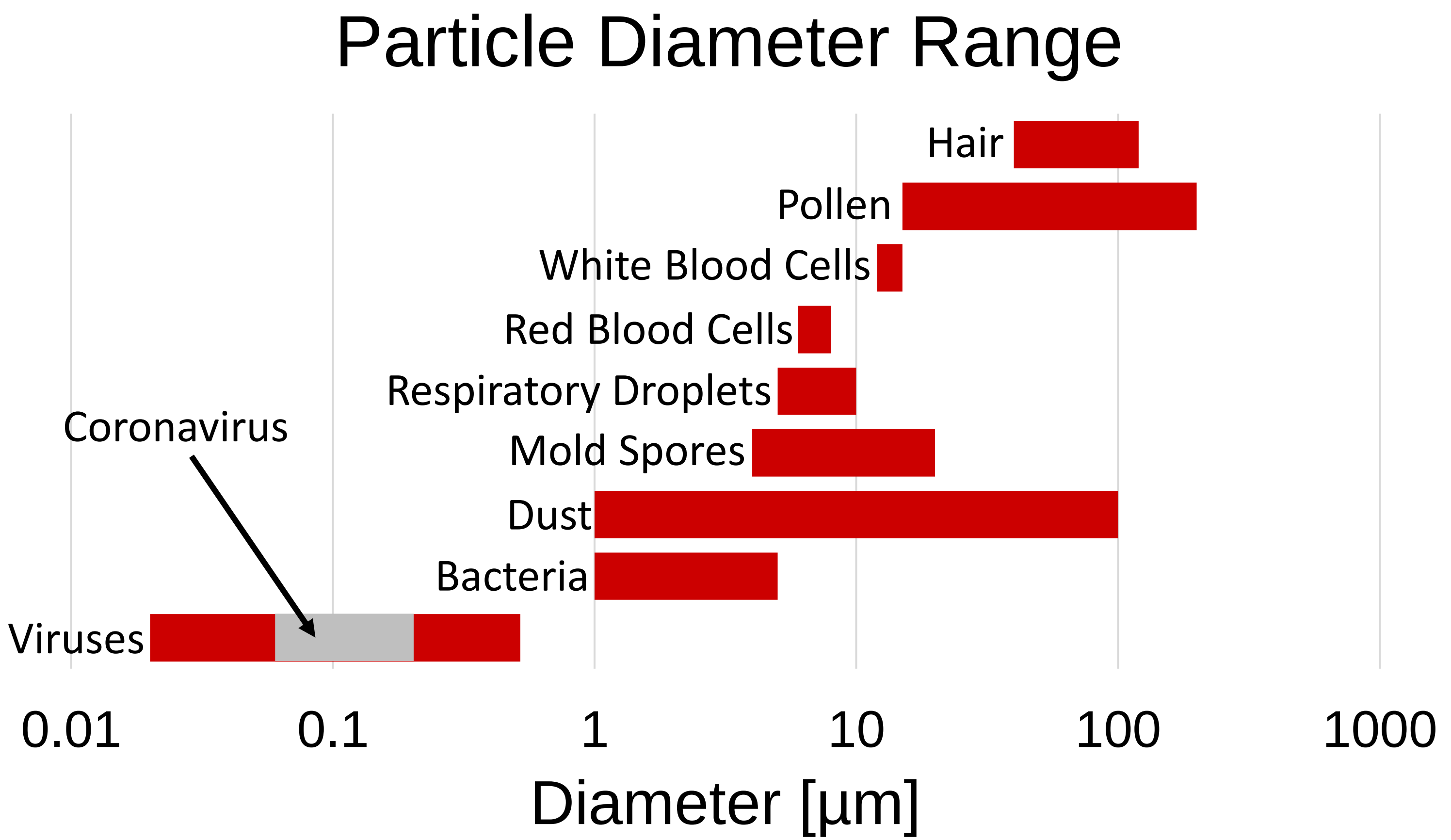
Sourced: Honeywell.com

Emma Martin

Improve Air Composition



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Emma Martin

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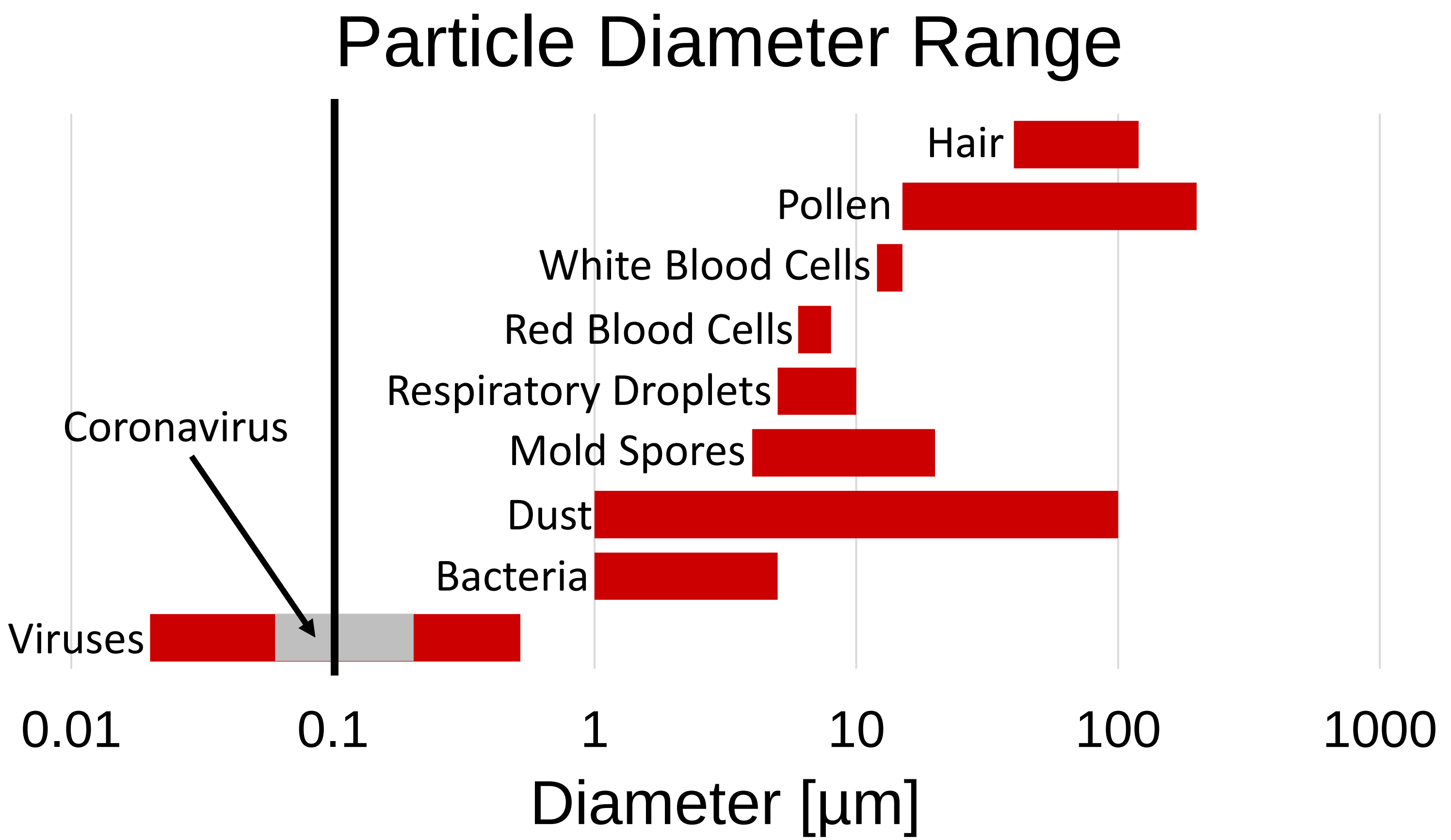

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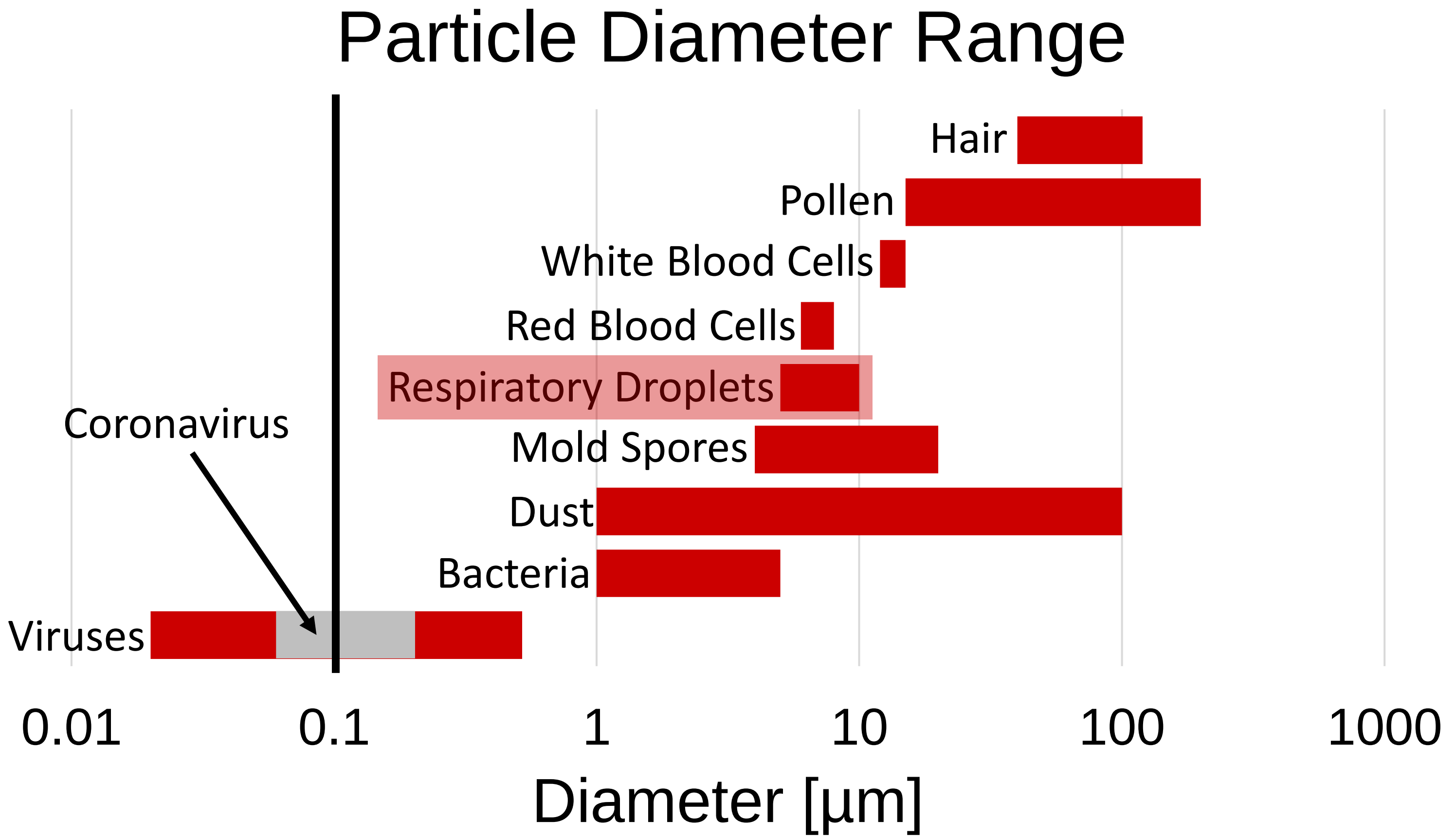
Sourced: Honeywell.com

Emma Martin

Improve Air Composition



Filter Particulates

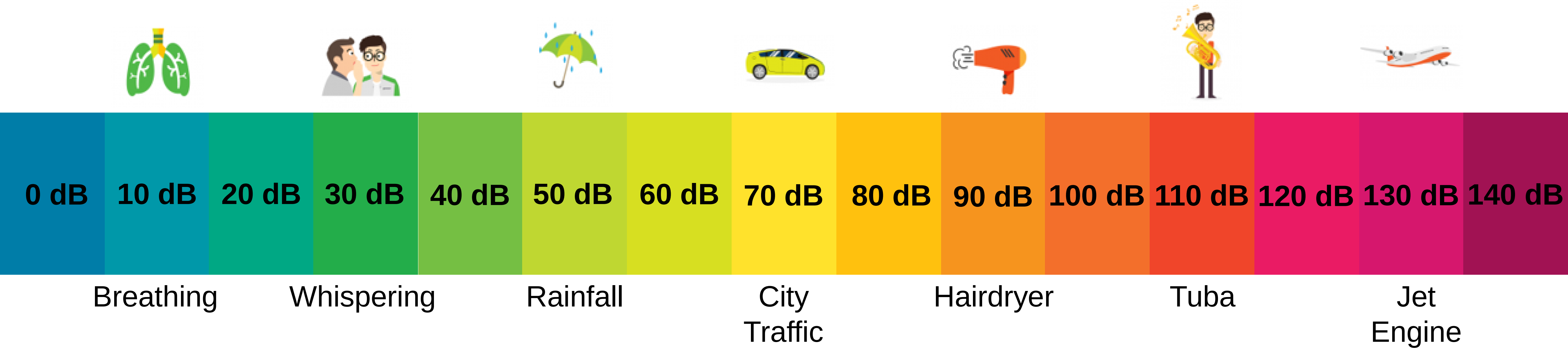
Minimum diameter of filterable particles

- 0.1 µm

Sourced: Honeywell.com

Emma Martin

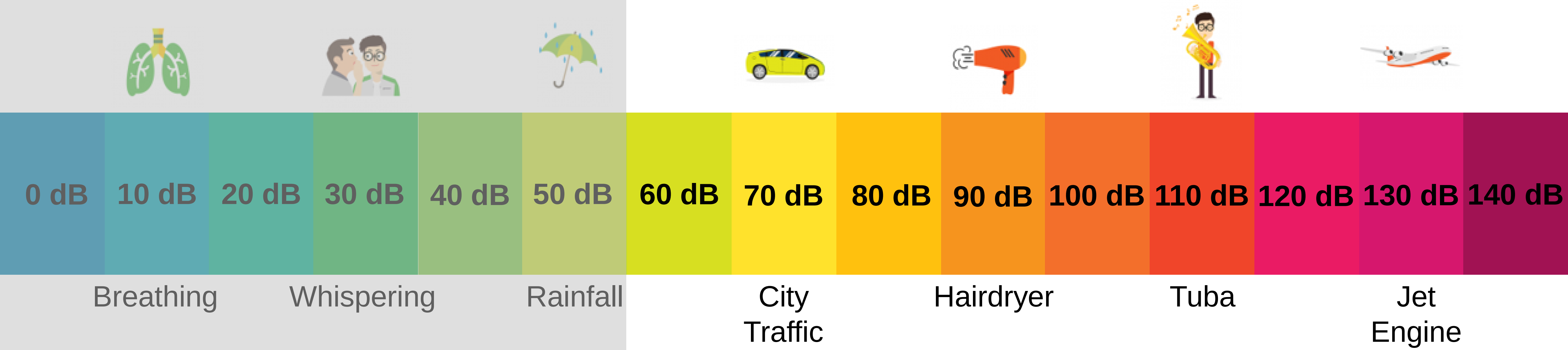
Noise



Sourced: LetsTalkScience.ca

Emma Martin

Noise



Device Noise

Maximum noise level

- 50 dB

Sourced: LetsTalkScience.ca

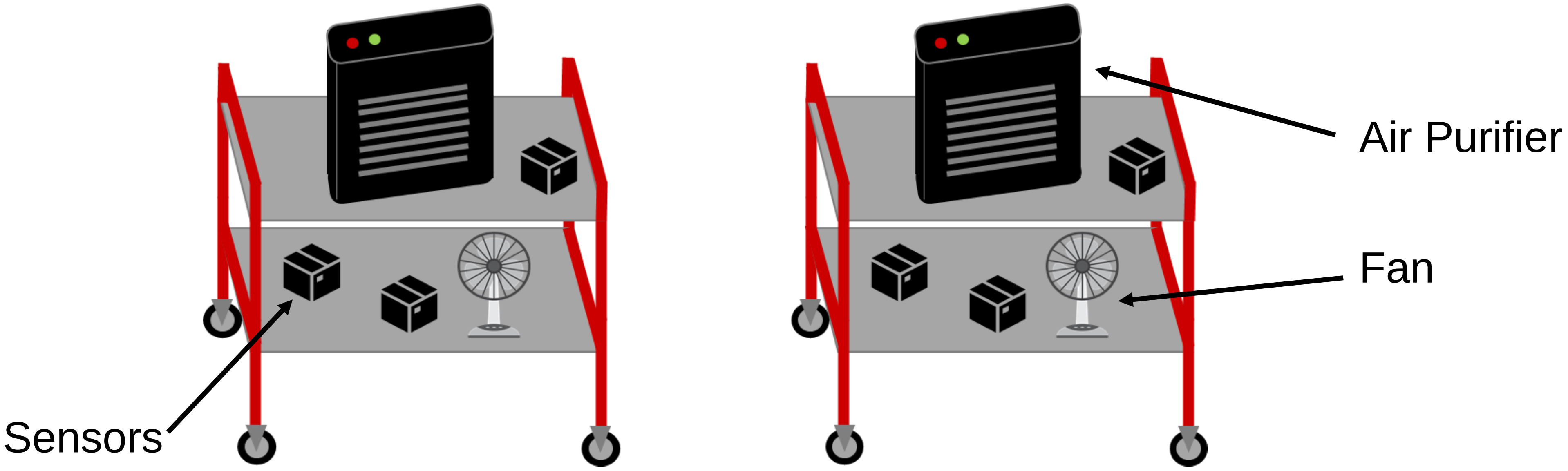
Emma Martin

Concept Selection and Bill of Materials

Eric Grogans

Final Concept

- Dual Cart Sensing and Cleaning Stations
- Each cart contains identical equipment
- One cart for short-term testing and one for long-term testing



Eric Grogans

Equipment and Data Storage

Utility Cart

JACE 8000 Controller

Sourced: Honeywell.com

Eric Grogans

Power

24v/120v AC Power Supply

Uninterruptable Power Supply

Energy Monitor

Sourced: Grainger.com, APC.com, Kele.com

Eric Grogans

Sensing

Room Indoor Air Quality Sensor

Handheld Particulate Matter Sensor

Sourced: Honeywell.com

Eric Grogans

Cleaning

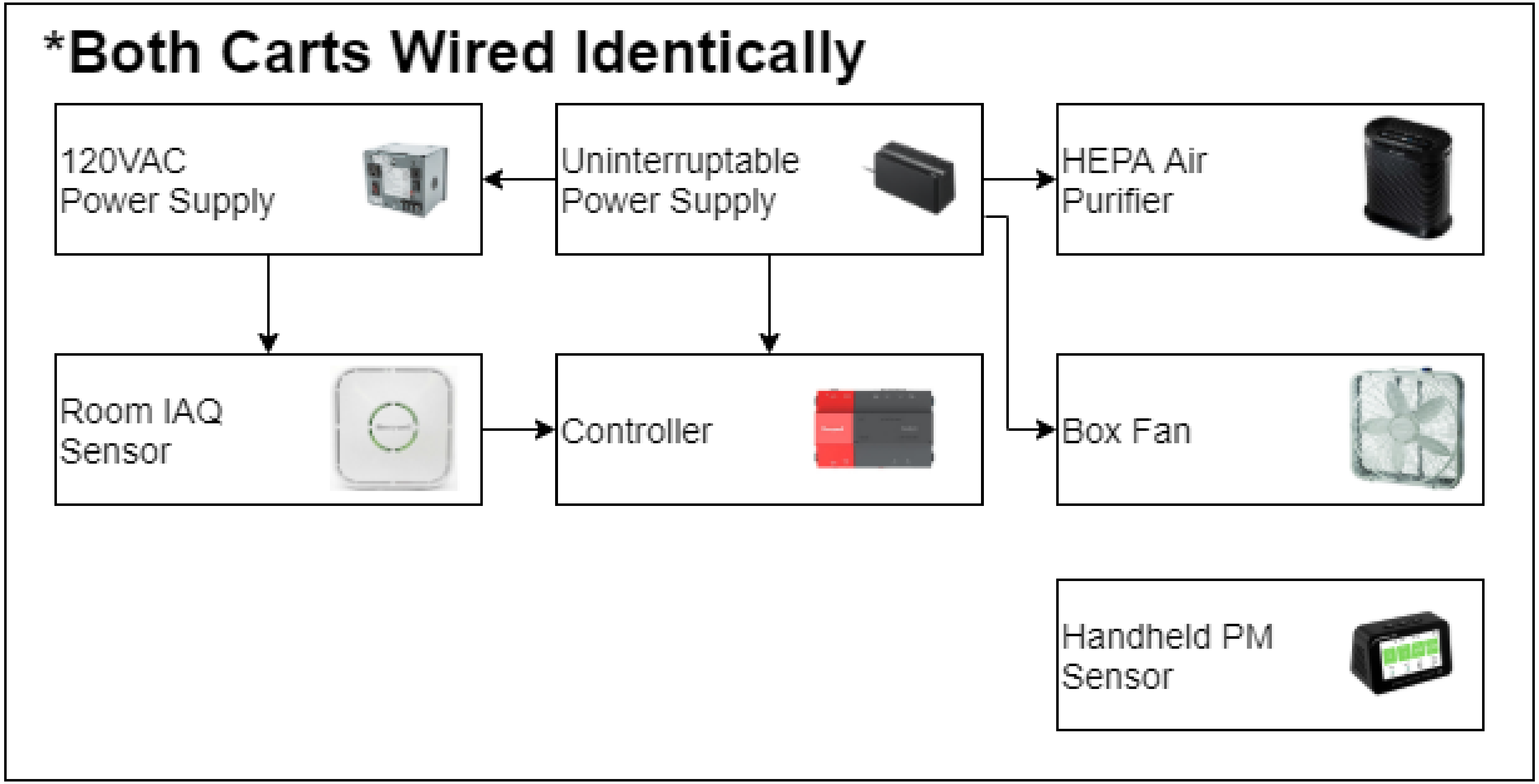
HEPA Air Purifier

Box Fan

Sourced: Honeywell.com, Overstock.com

Eric Grogans

Connection Diagram



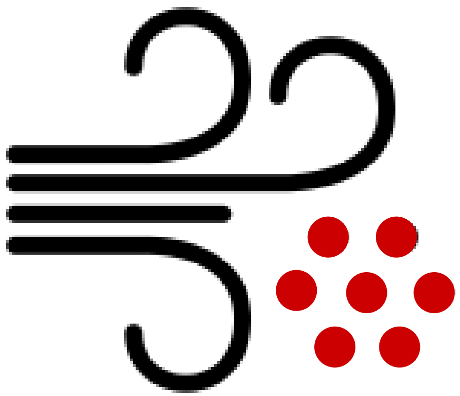
Sourced: Honeywell.com, APC.com, Grainger, APC.com, Overstock

Eric Grogans

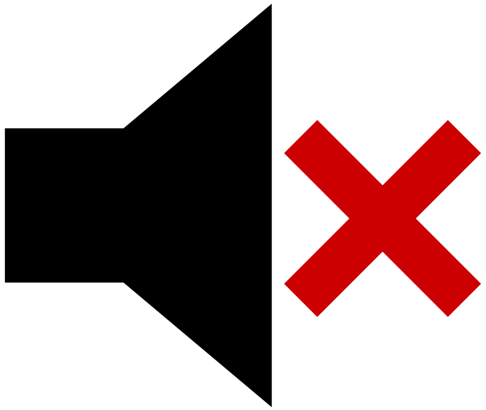
Testing Plans

Whitley Pettis & Emma Martin

Preliminary Tests



Measure air quality before cleaning

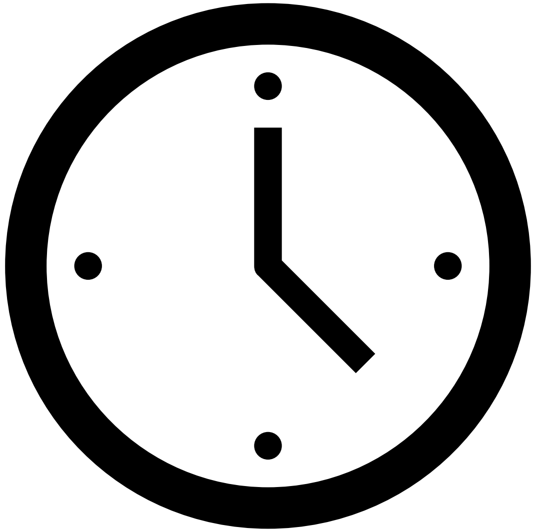


Measure equipment noise levels before placement

Whitley Pettis

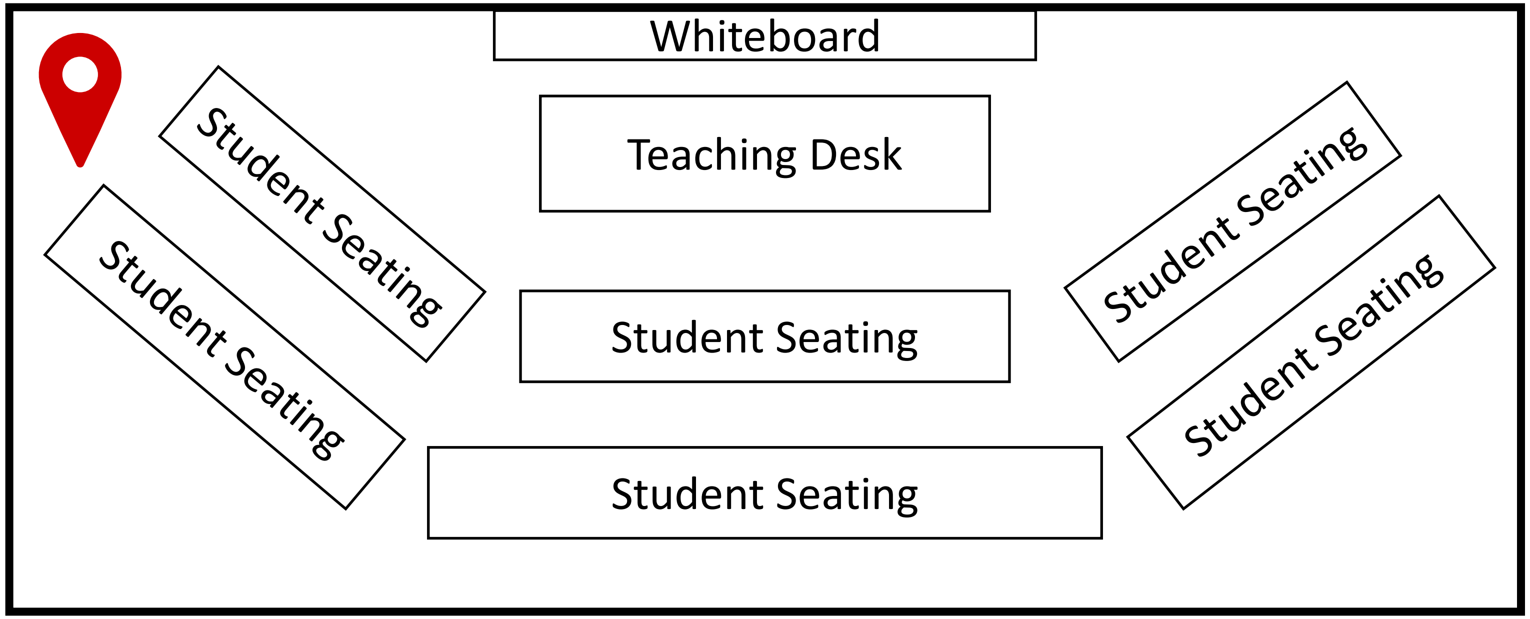
Testing Procedures

- 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

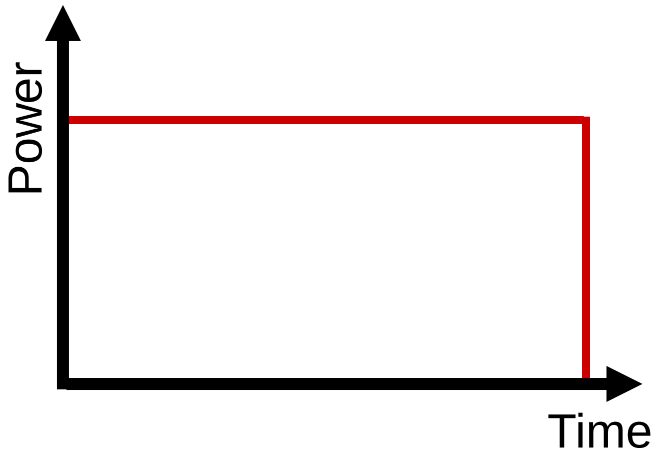
Testing Procedures

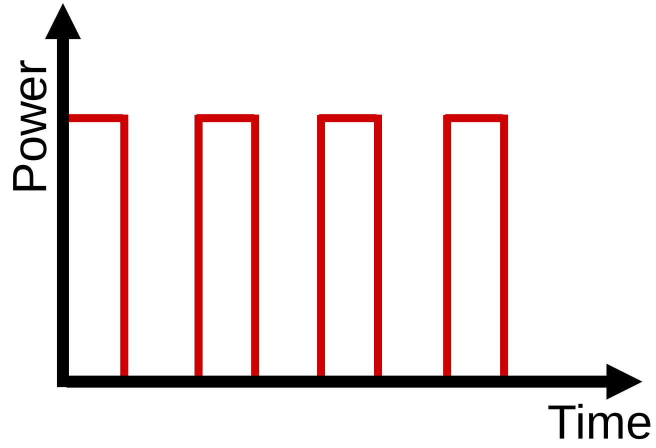


- Move cleaning equipment to different locations in the same room
- Monitor whether certain locations are more effective for improving the room's air quality

Emma Martin

Testing Procedures





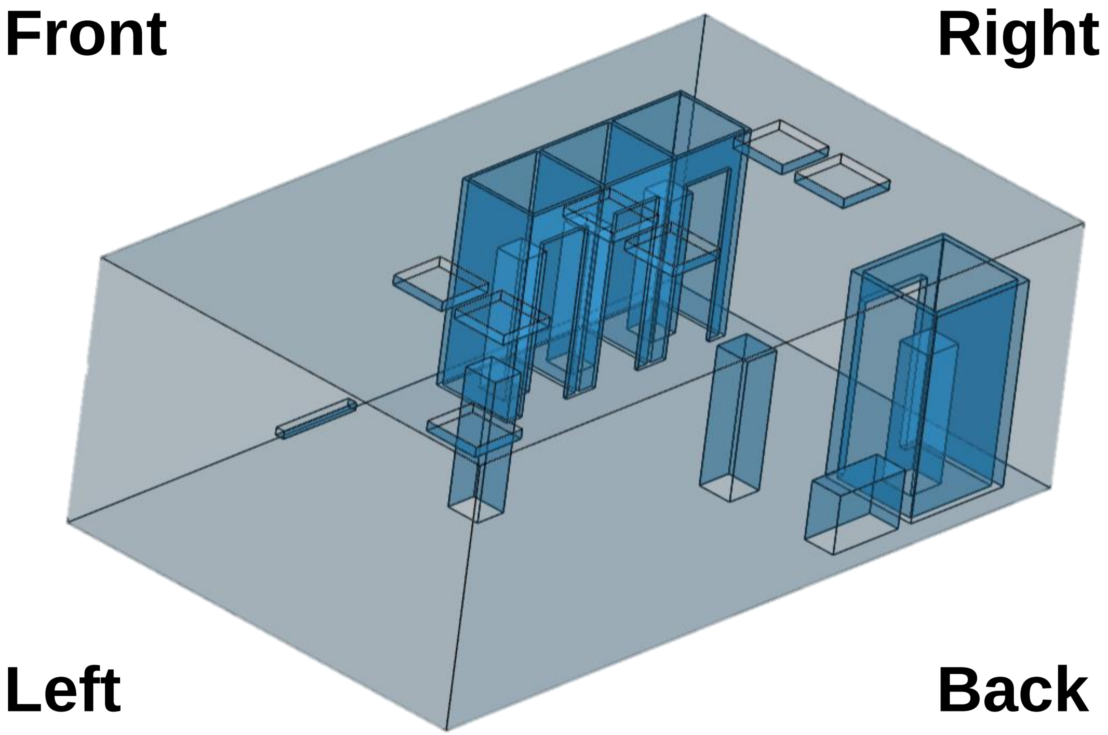
- Run cleaning equipment constantly then intermittently in the same location
- Compare recorded air quality from the tests
- Use results to find the balance between energy consumption and cleaning efficiency

Emma Martin

Simulations

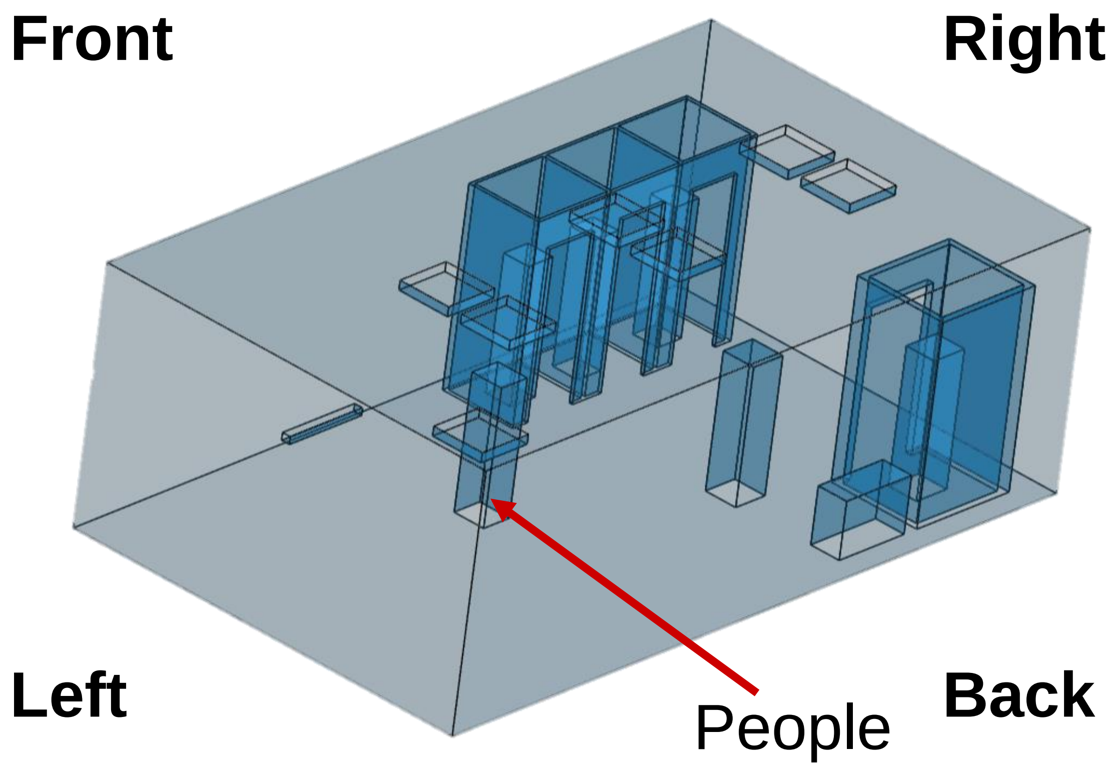
Razhan Matipano & Leon Johnson

Senior Design Lab Model



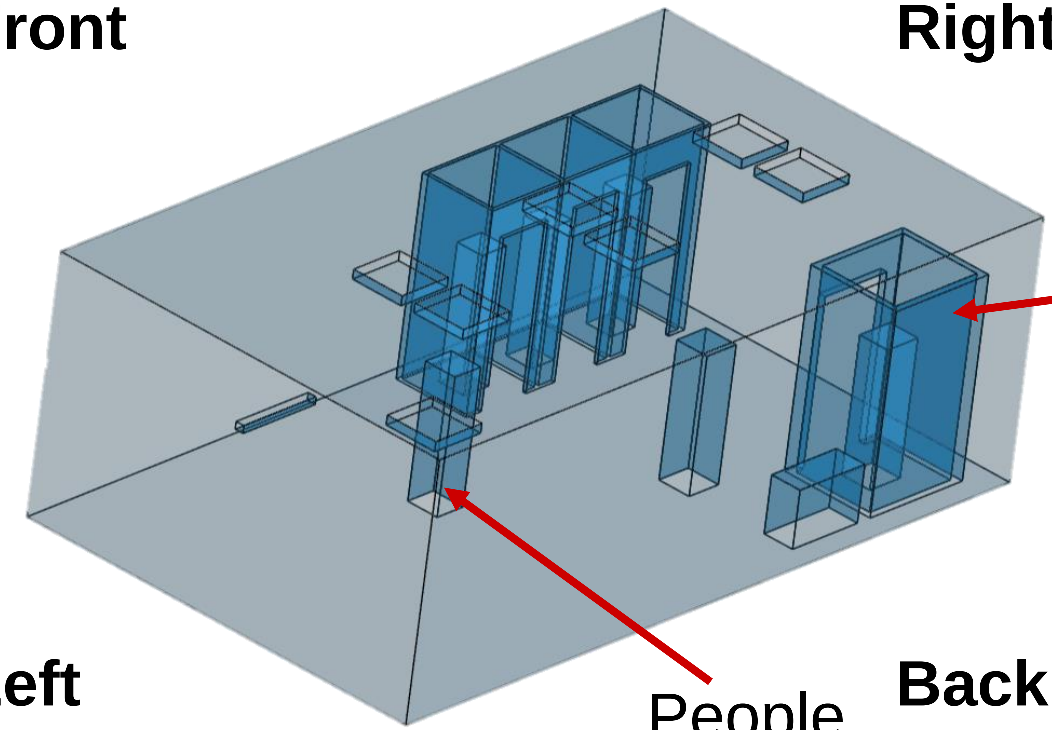
Razhan Matipano

Senior Design Lab Model



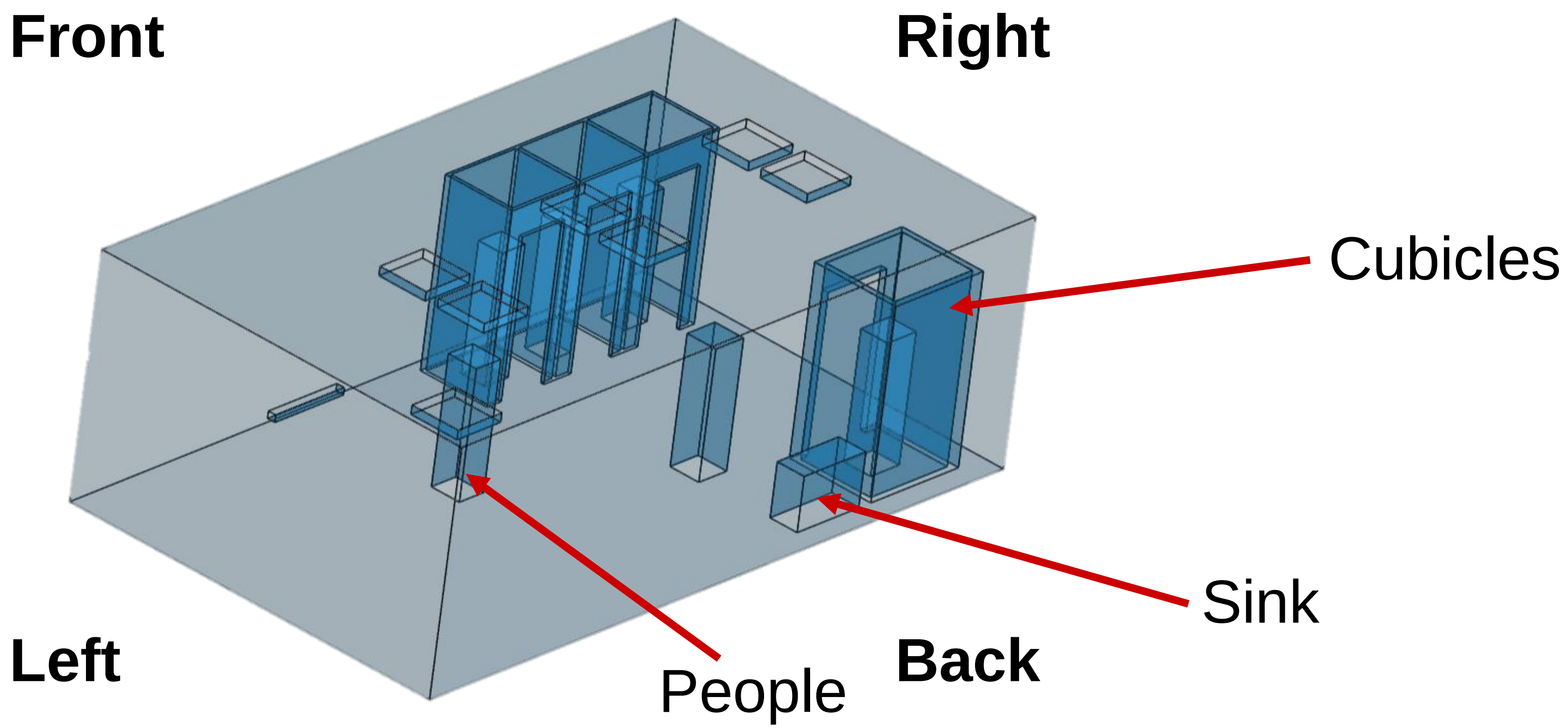
Razhan Matipano

Senior Design Lab Model



Razhan Matipano

Senior Design Lab Model



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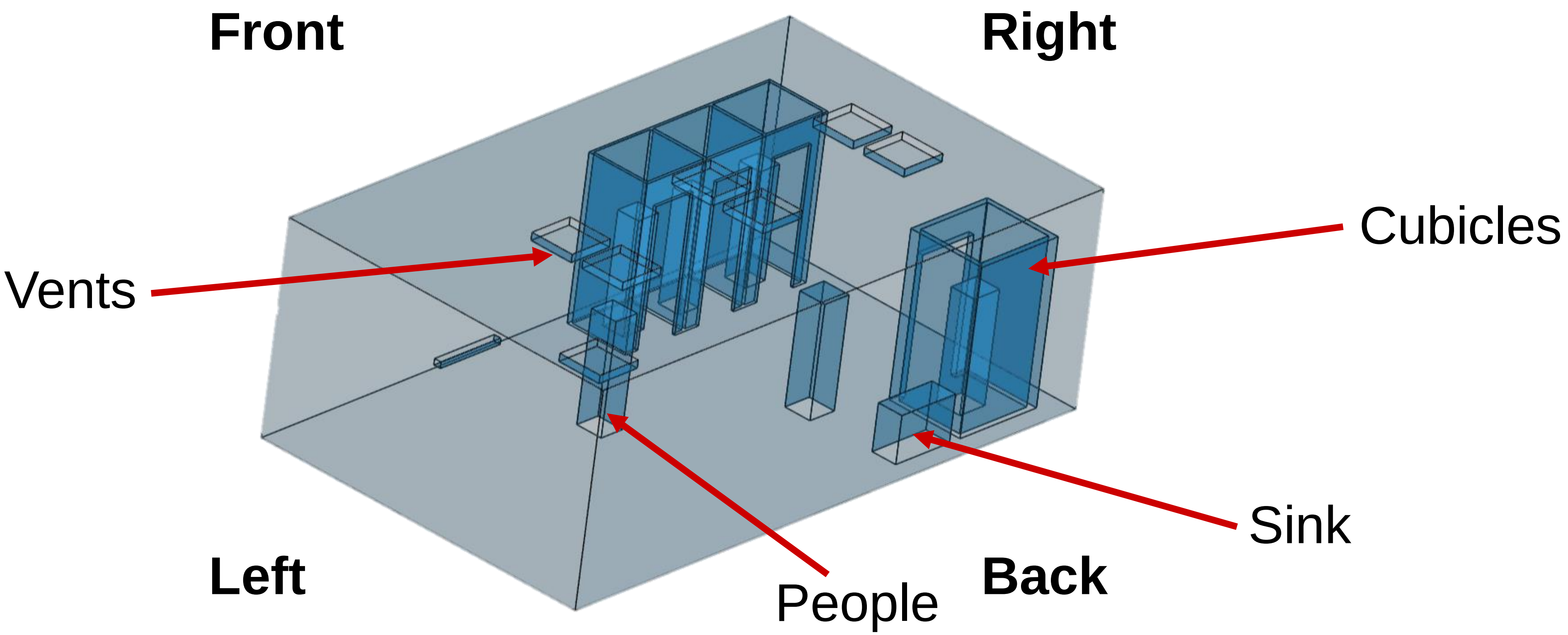
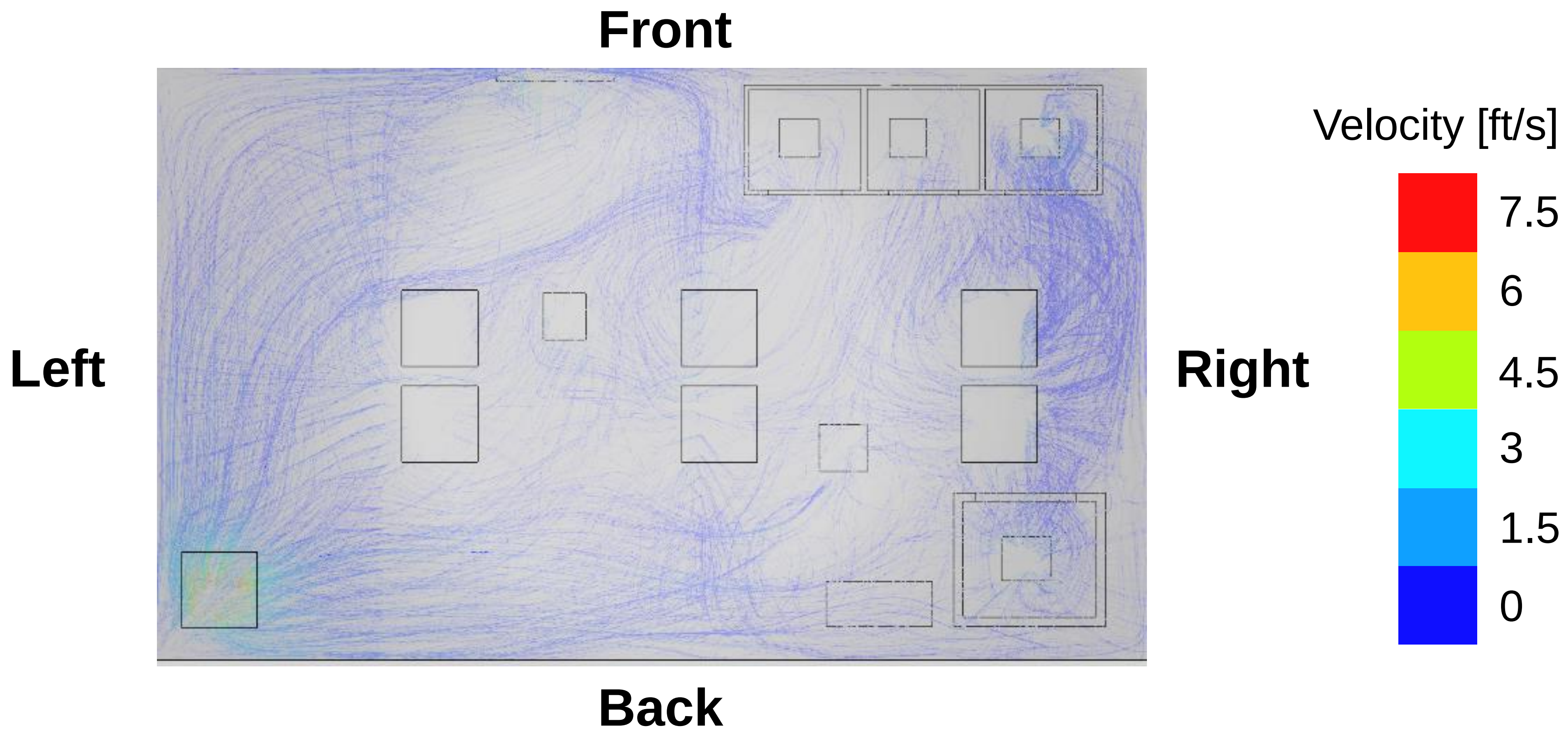


Razhan Matipano

SD Lab Simulation Top View



Razhan Matipano

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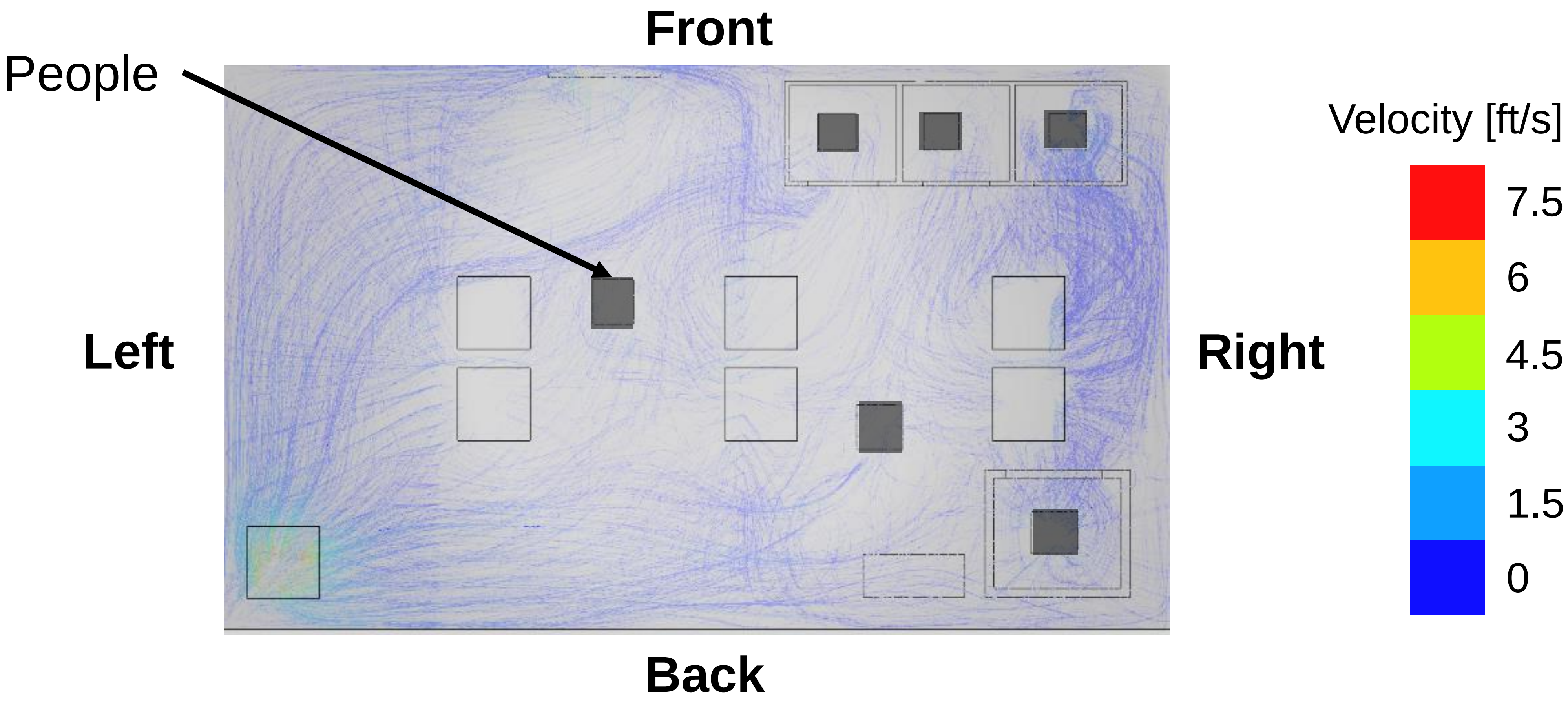

Razhan Matipano

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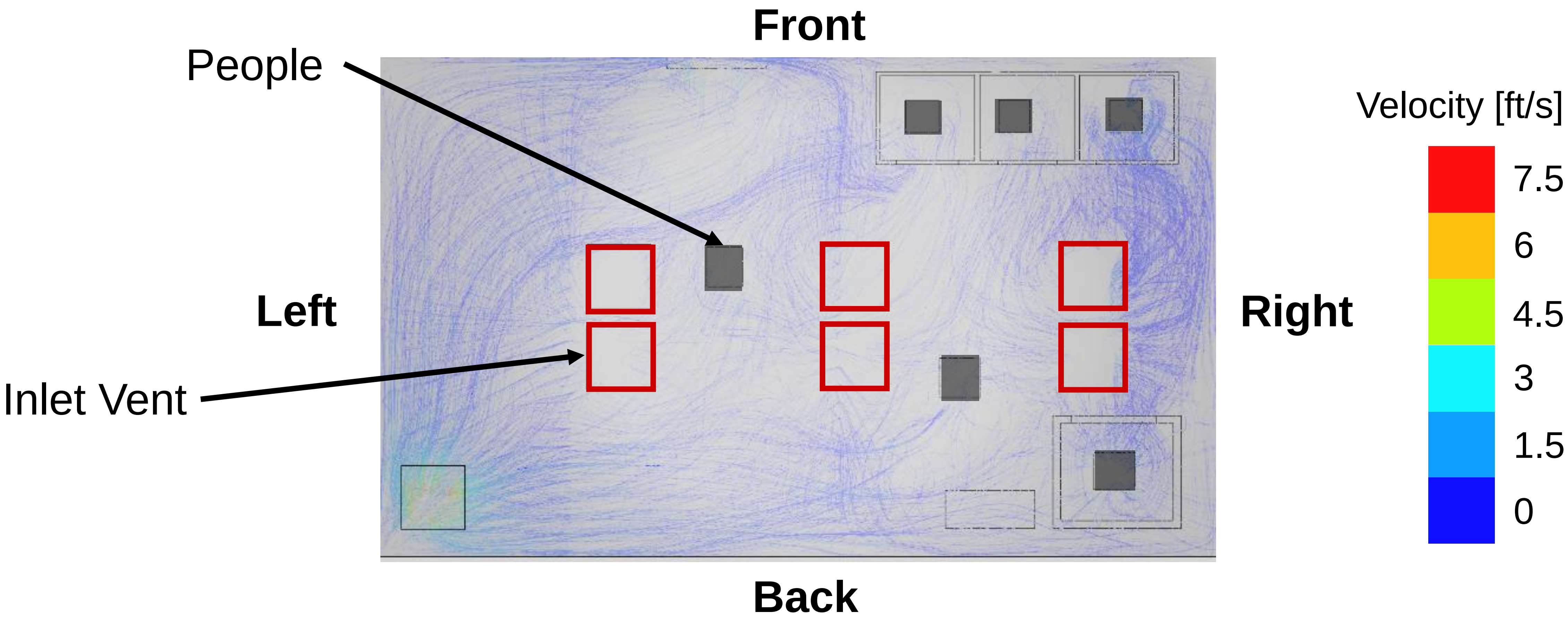

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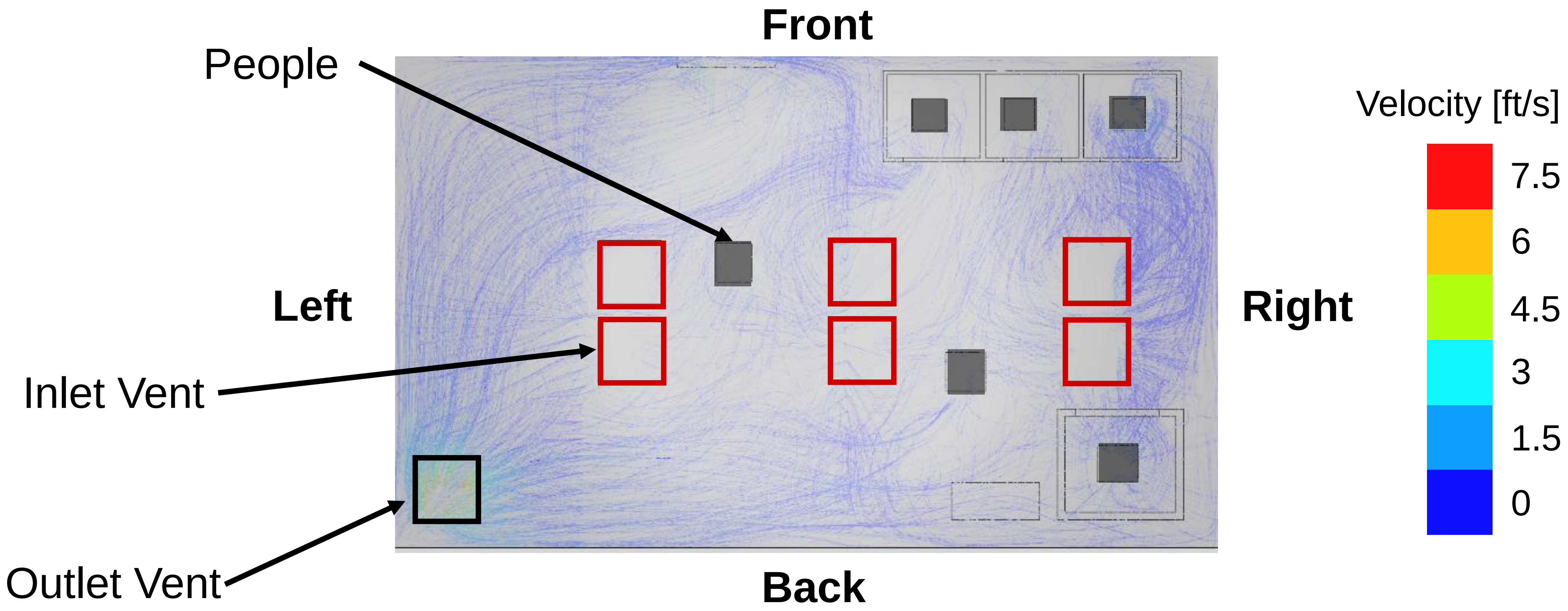

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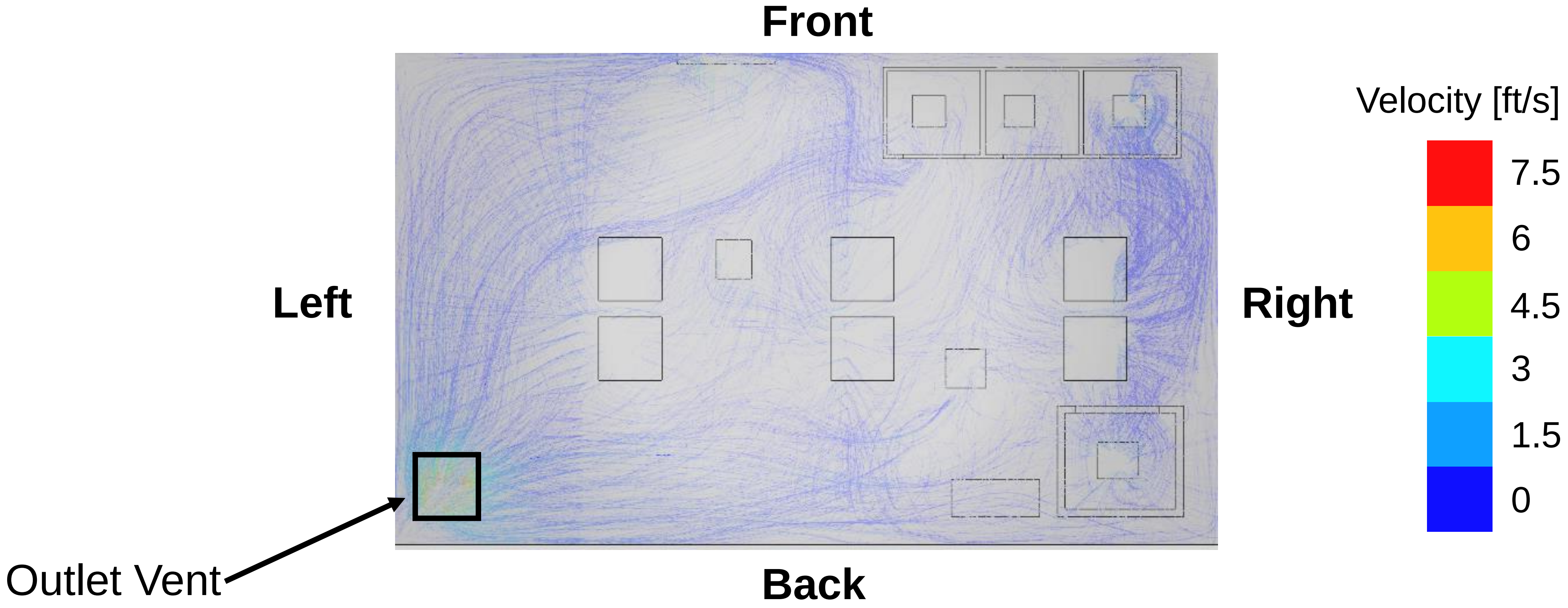

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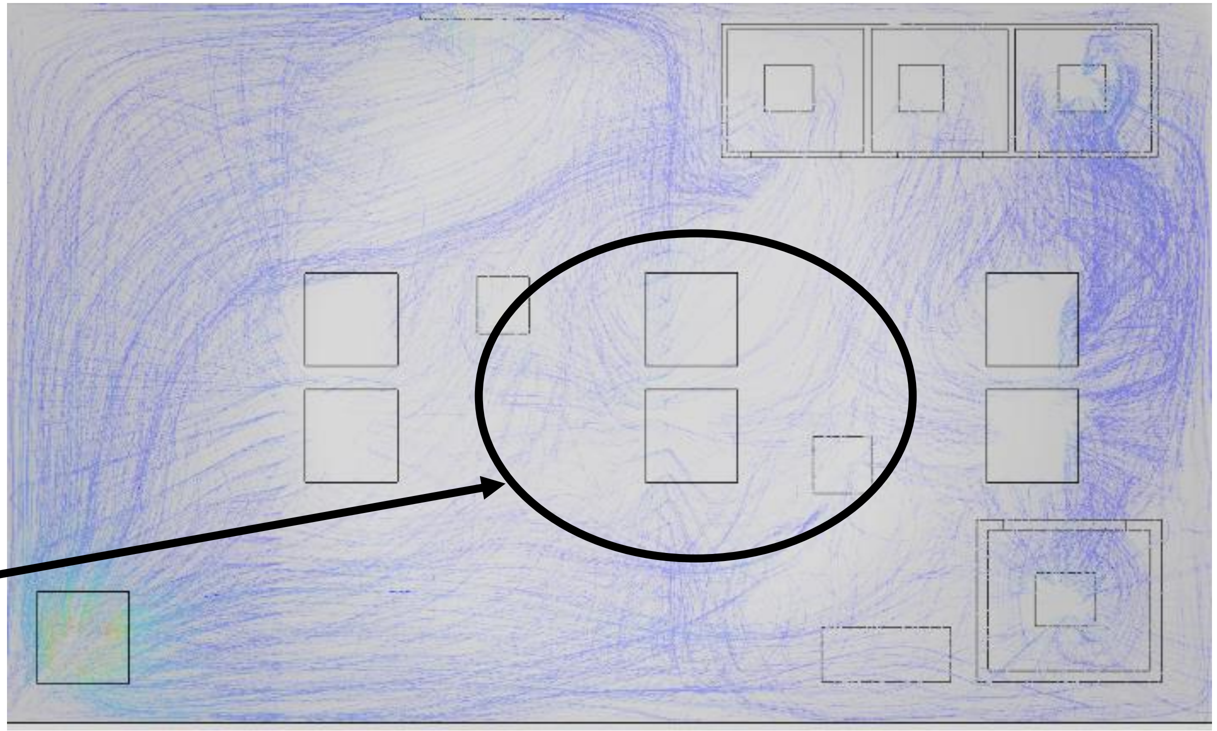


Place fans in low airflow areas

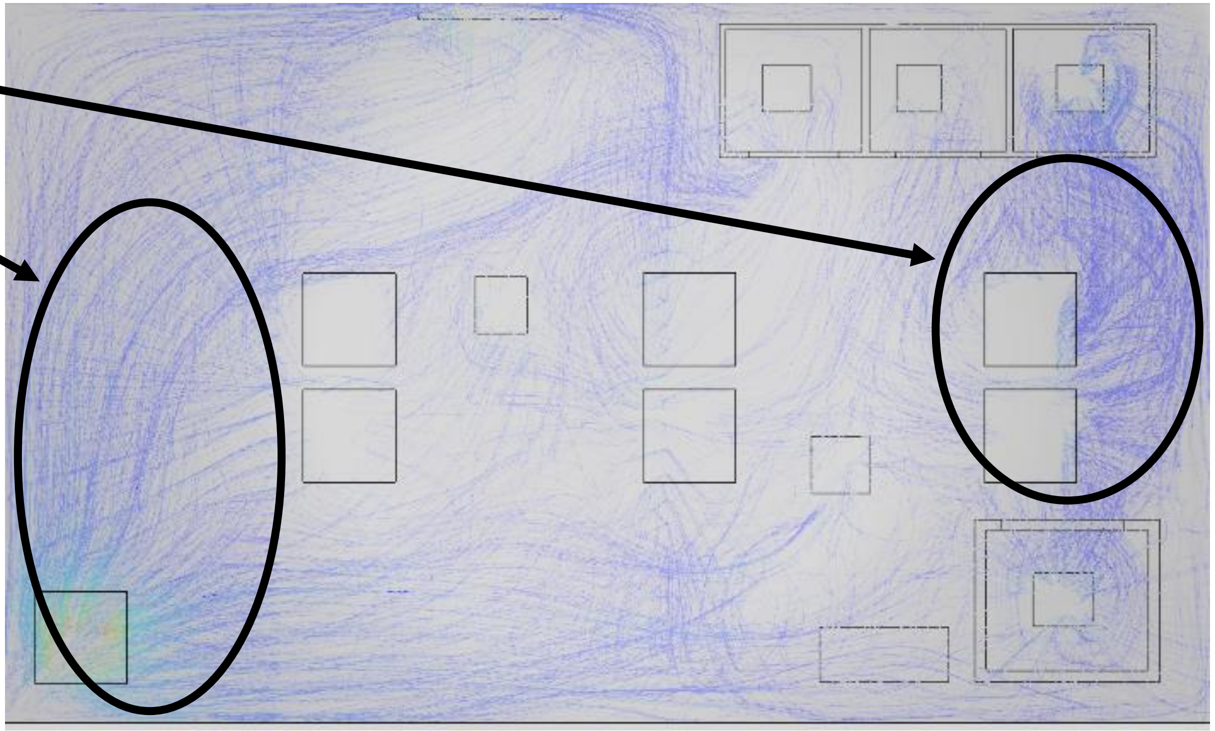
Razhan Matipano

SD Lab Simulation Top View

Place air purifiers in high airflow areas

Front

Left



Right

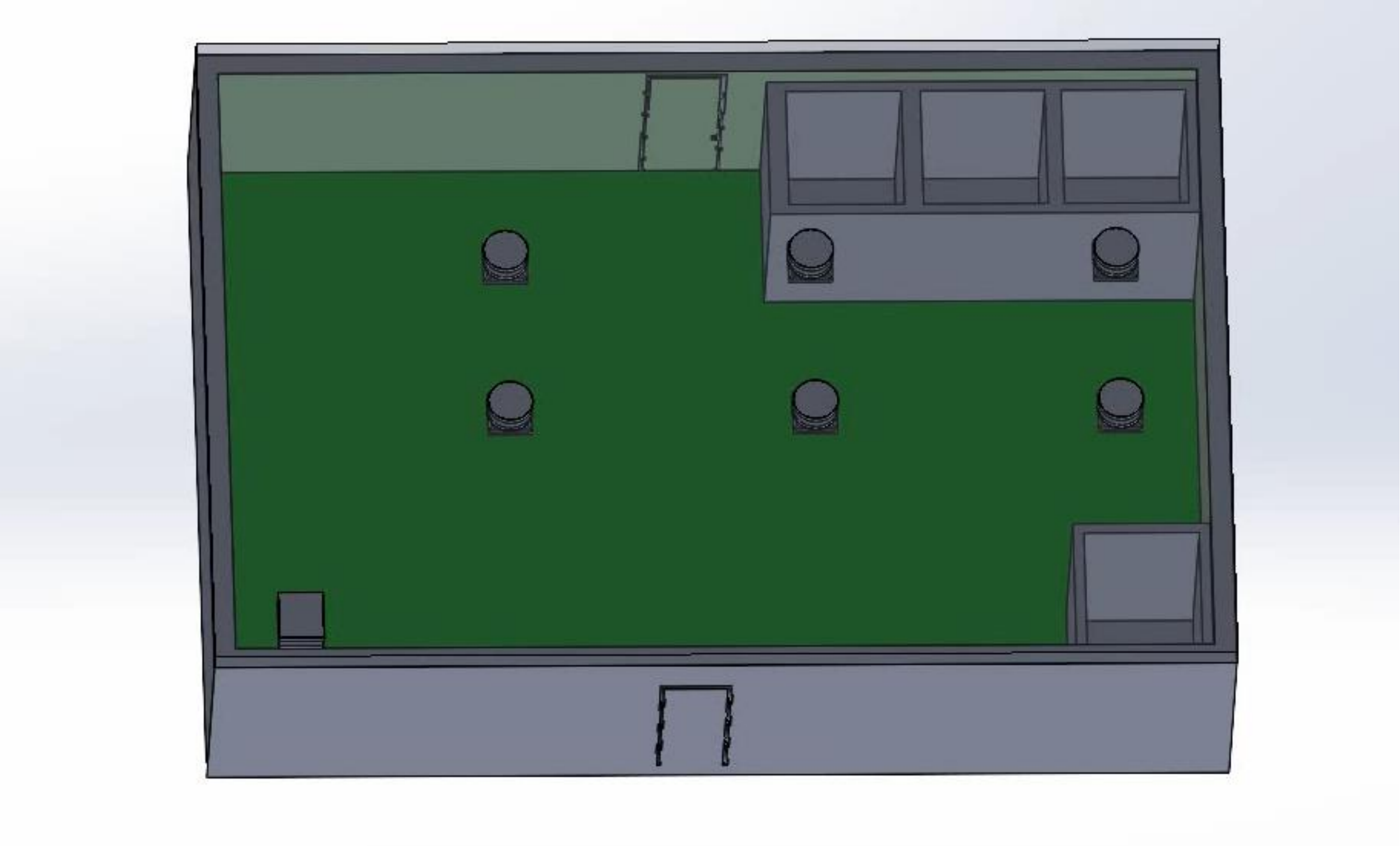
Back

Velocity [ft/s]

7.5
6
4.5
3
1.5
0

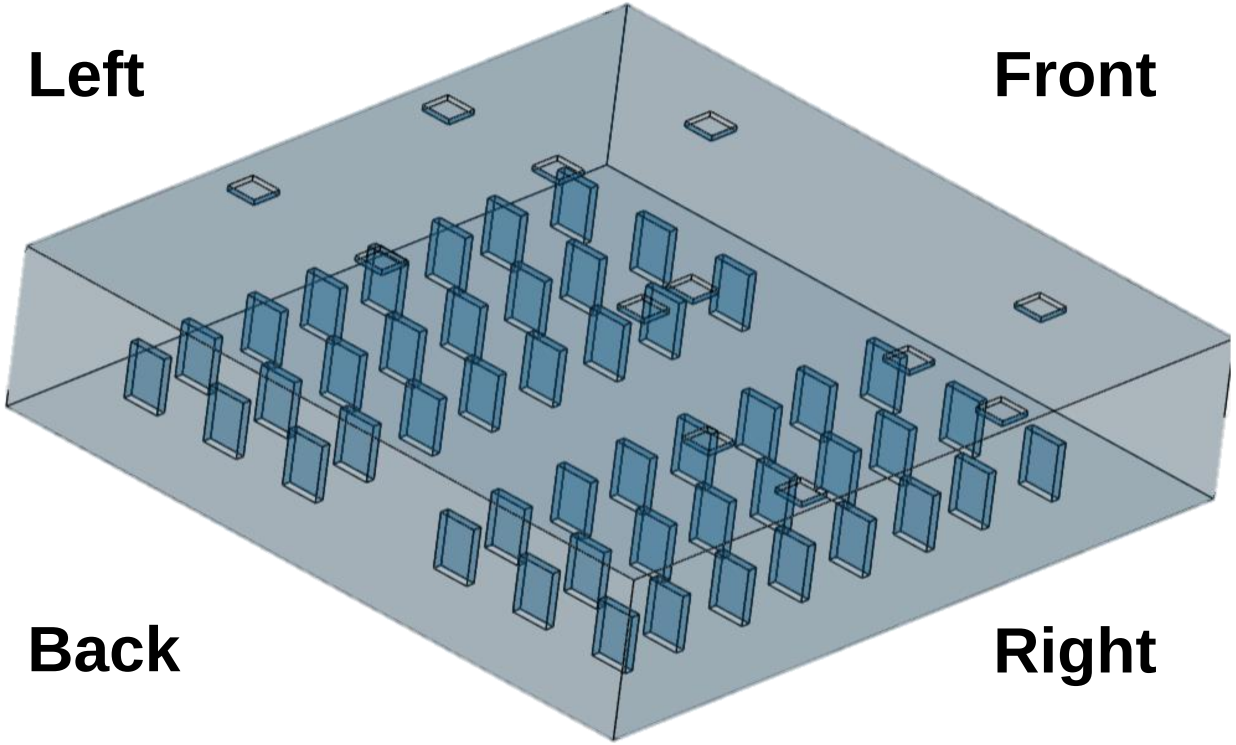
Razhan Matipano

SD Lab Simulation Top View



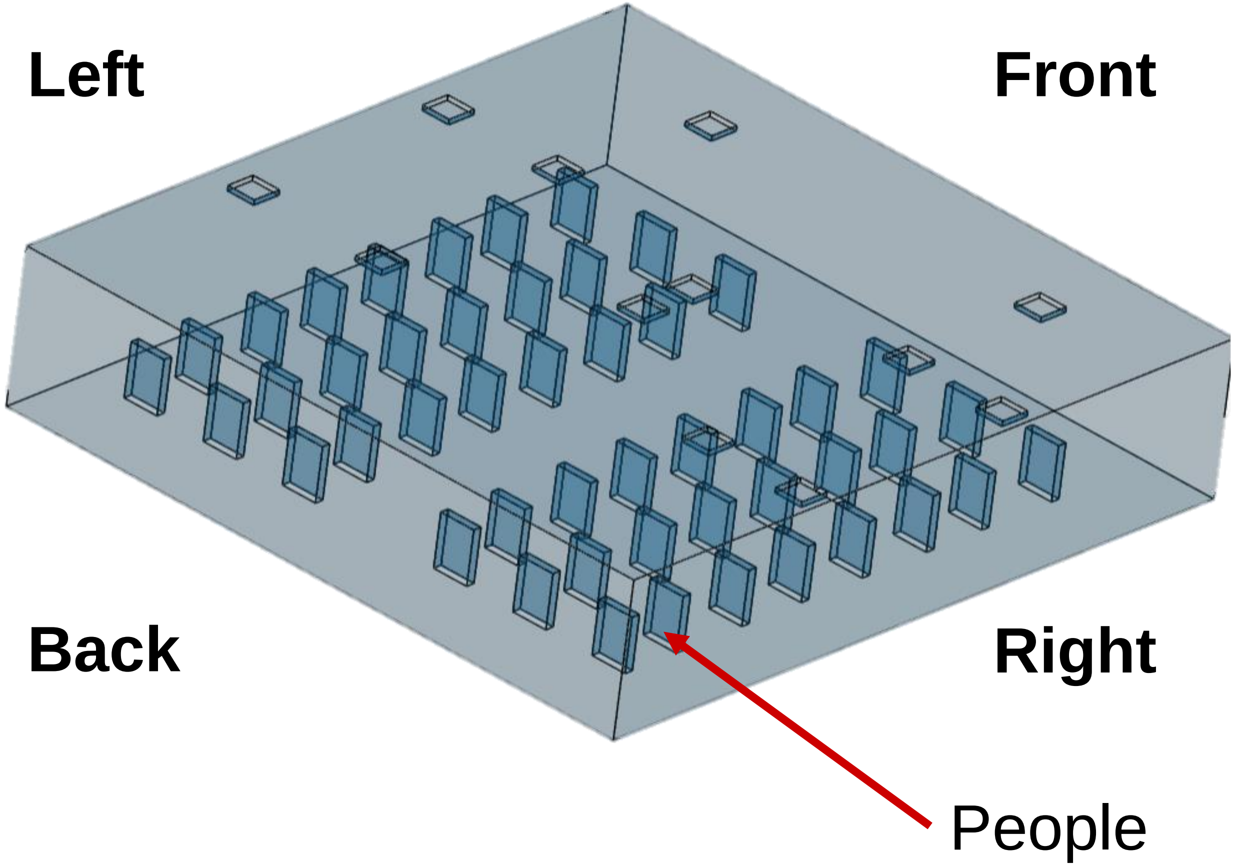
Razhan Matipano

B135 Model



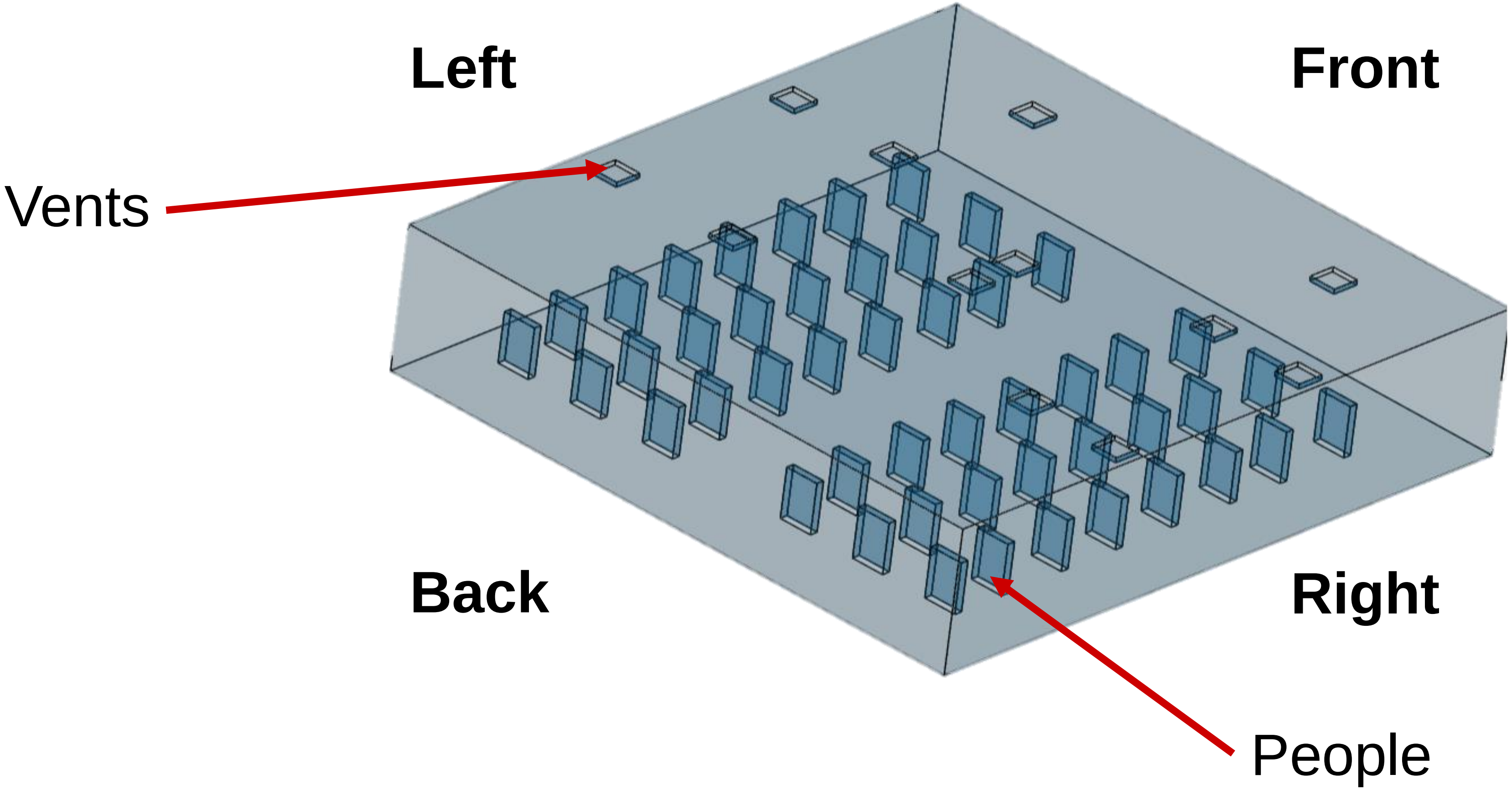
Leon Johnson

B135 Model



Leon Johnson

B135 Model

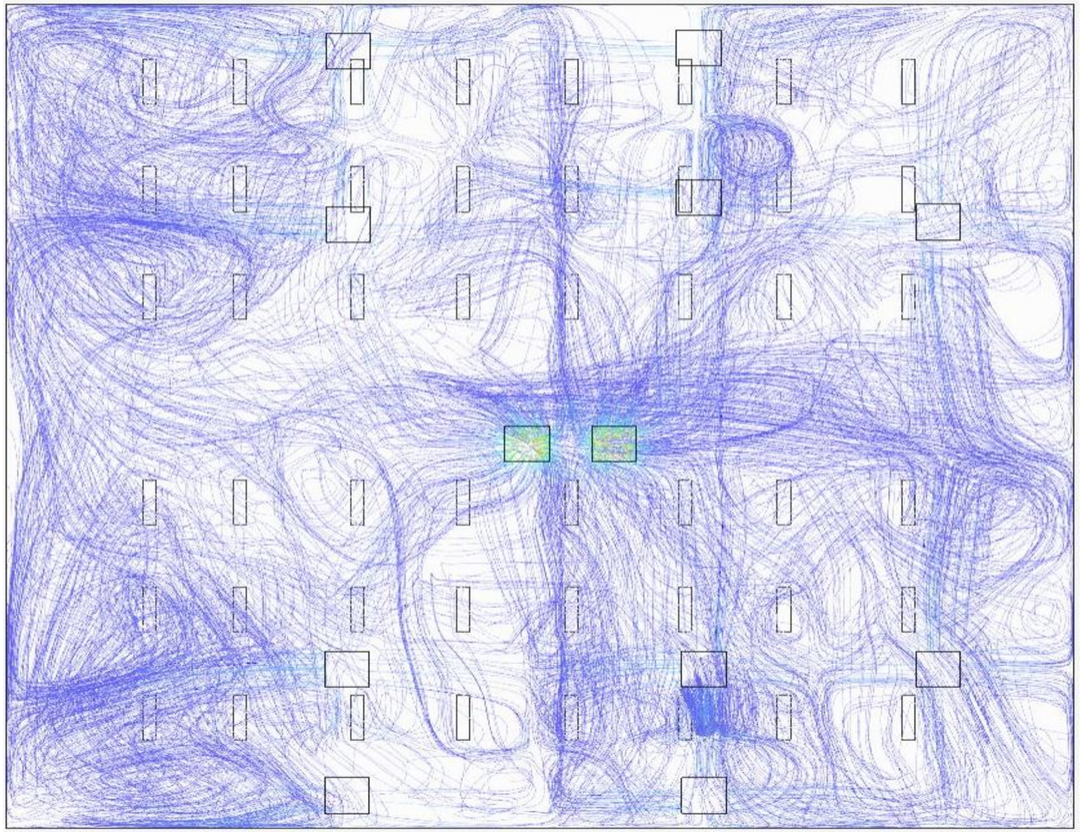


Leon Johnson

B135 Simulation – Top View

Left

Back



Front

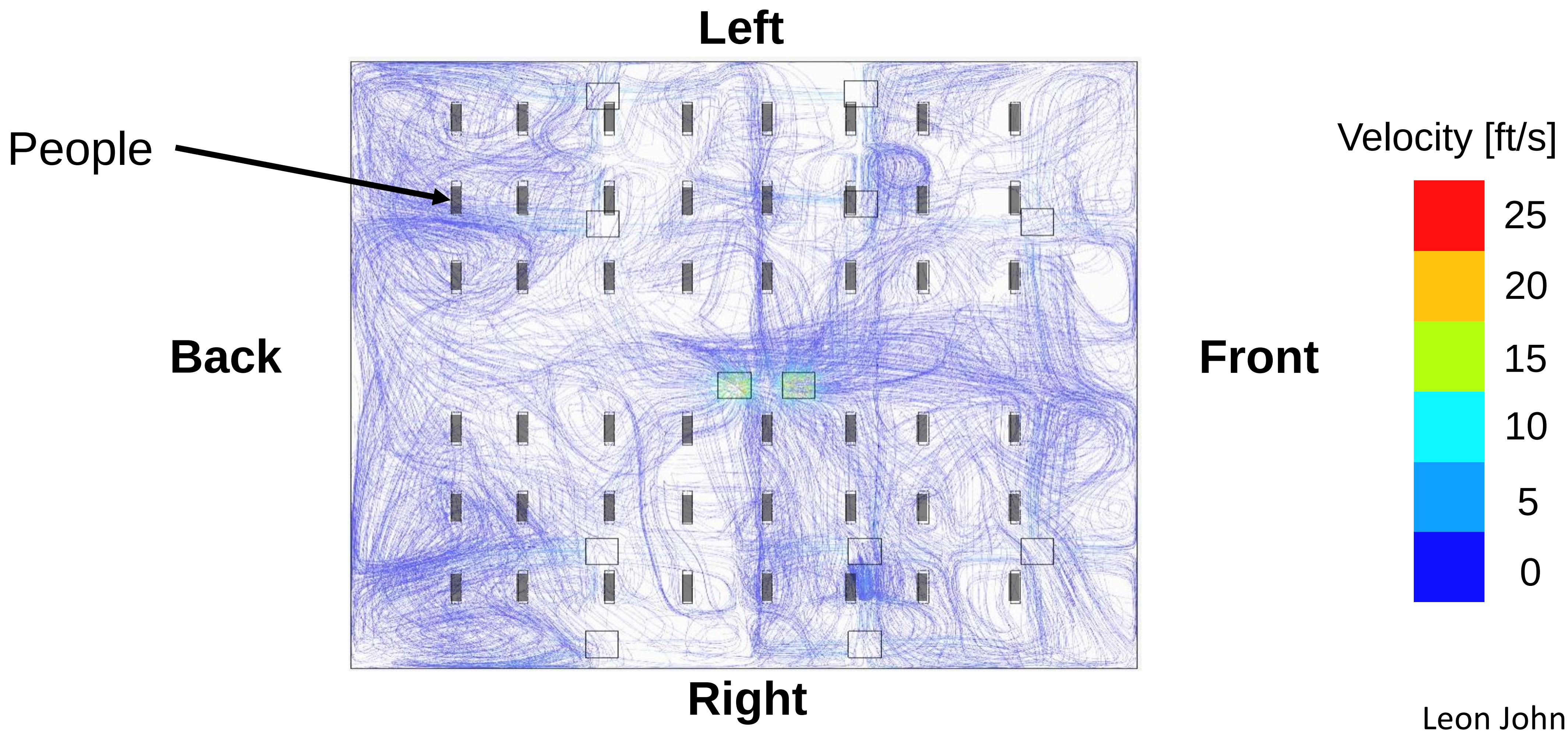
Right

Velocity [ft/s]

25
20
15
10
5
0

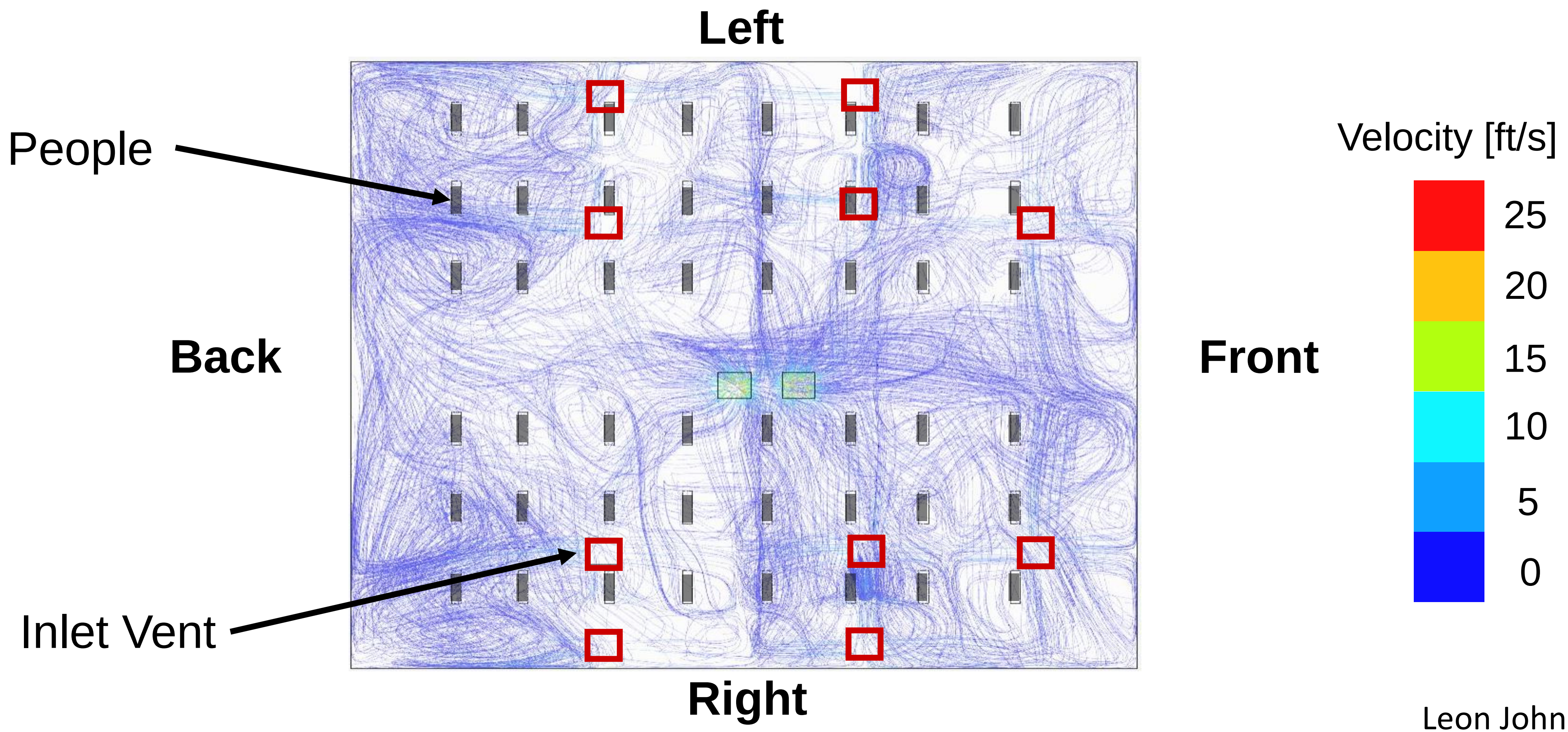
Leon Johnson

B135 Simulation – Top View



Leon Johnson

B135 Simulation – Top View



Leon Johnson

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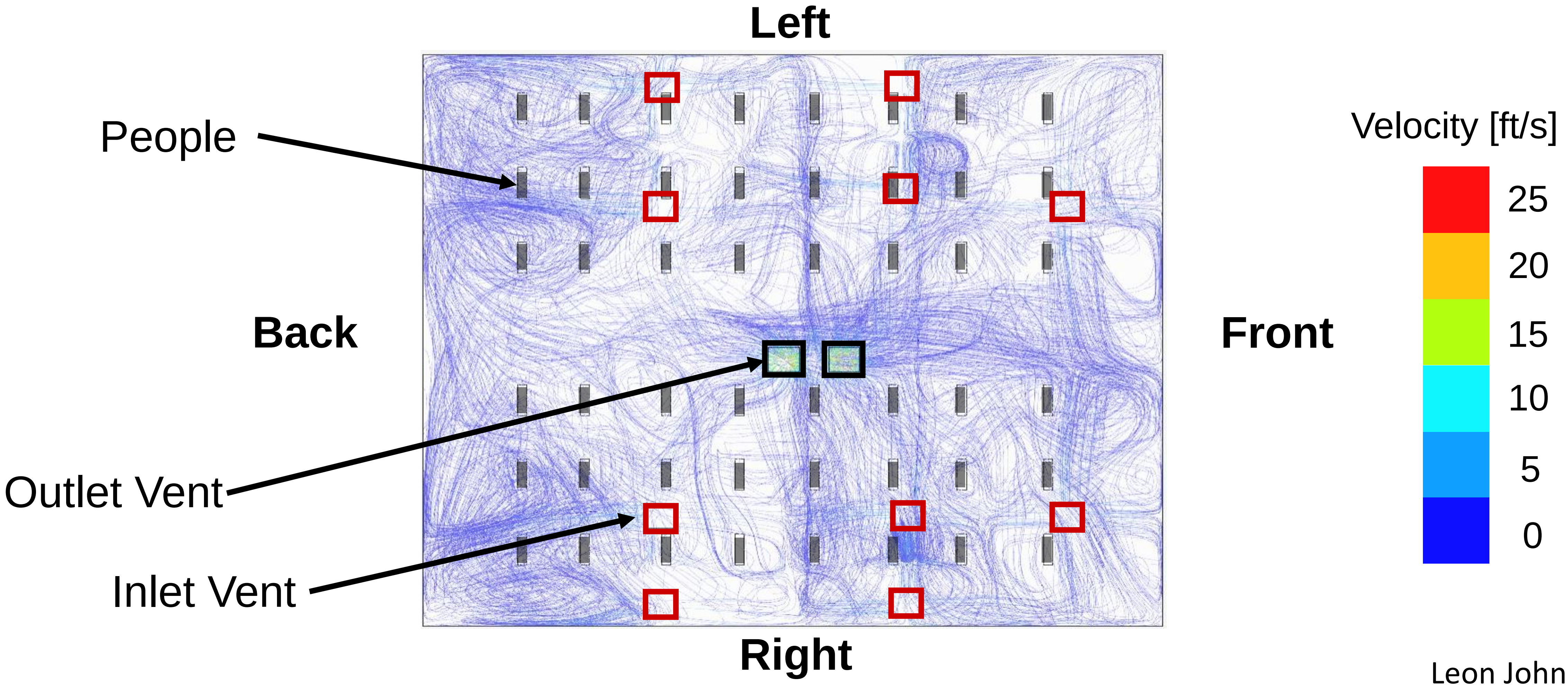

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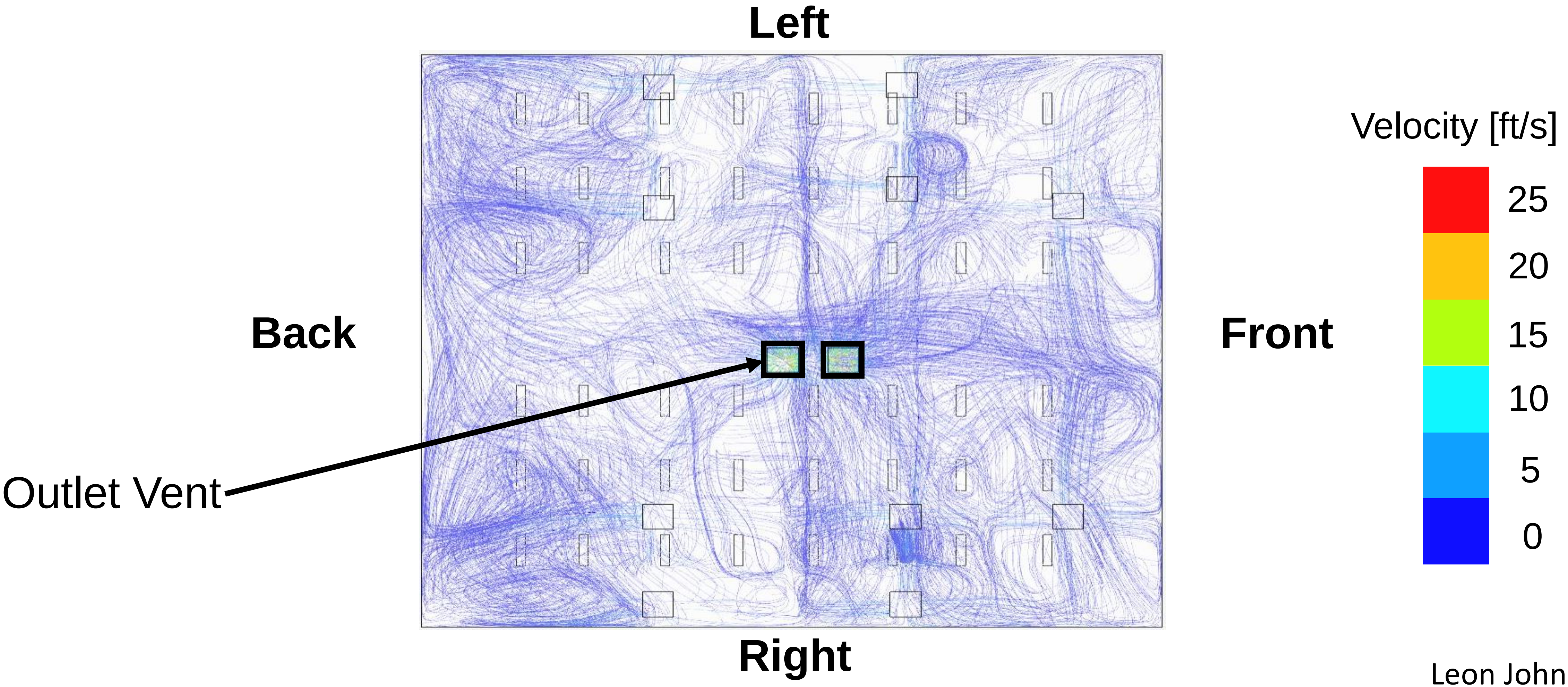

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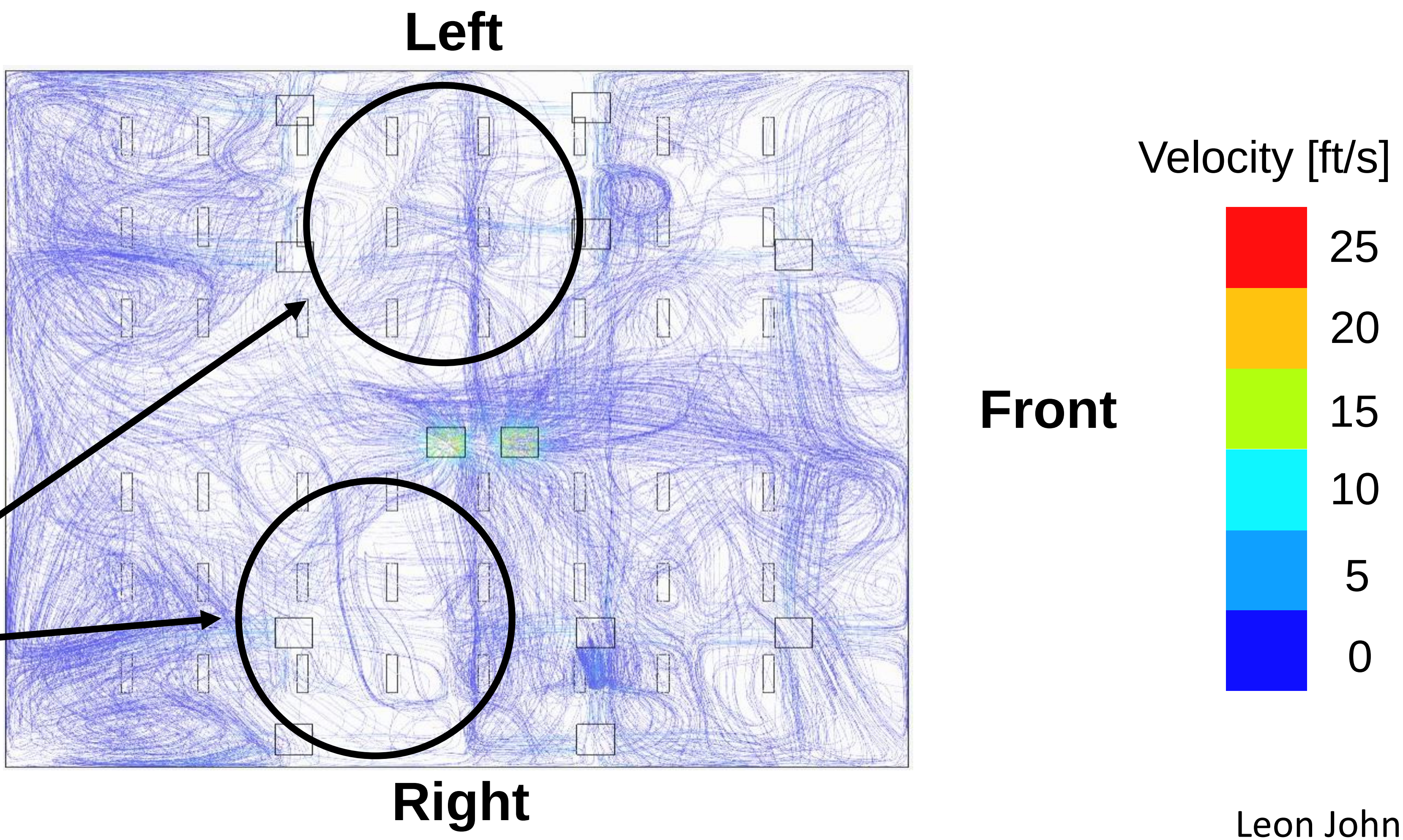

Place fans in low airflow areas

Leon Johnson

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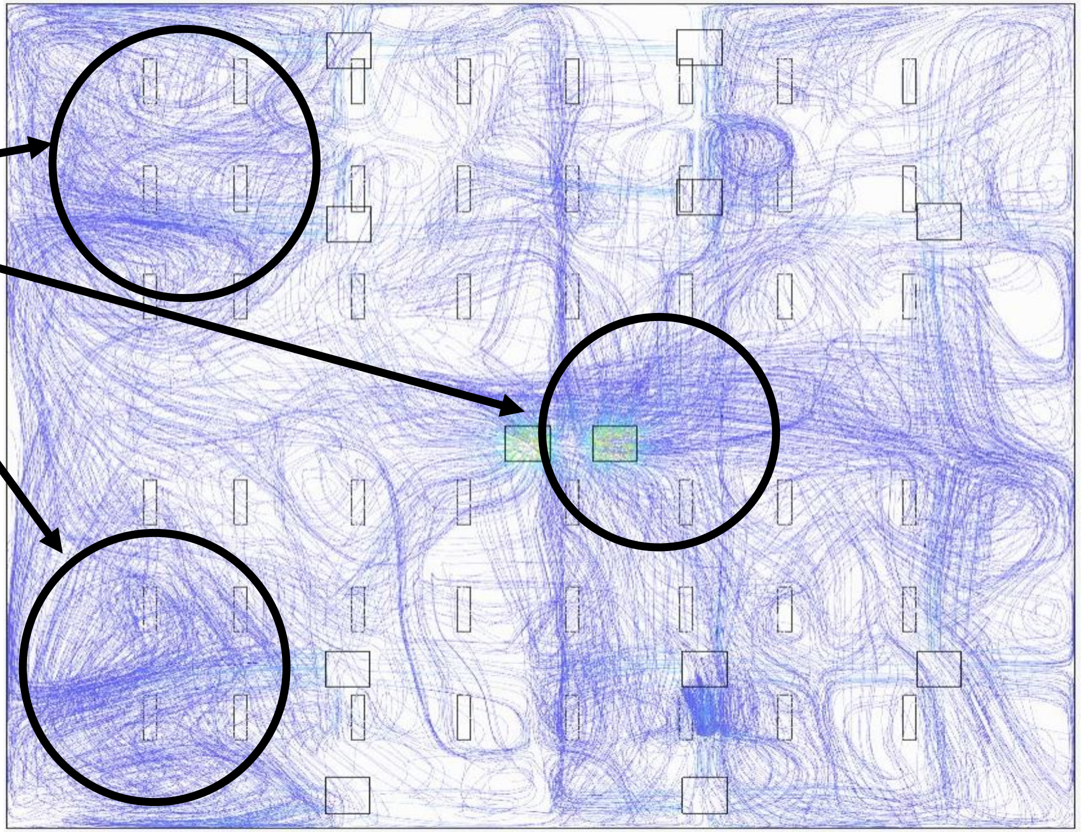


Back

Front

Right

Velocity [ft/s]

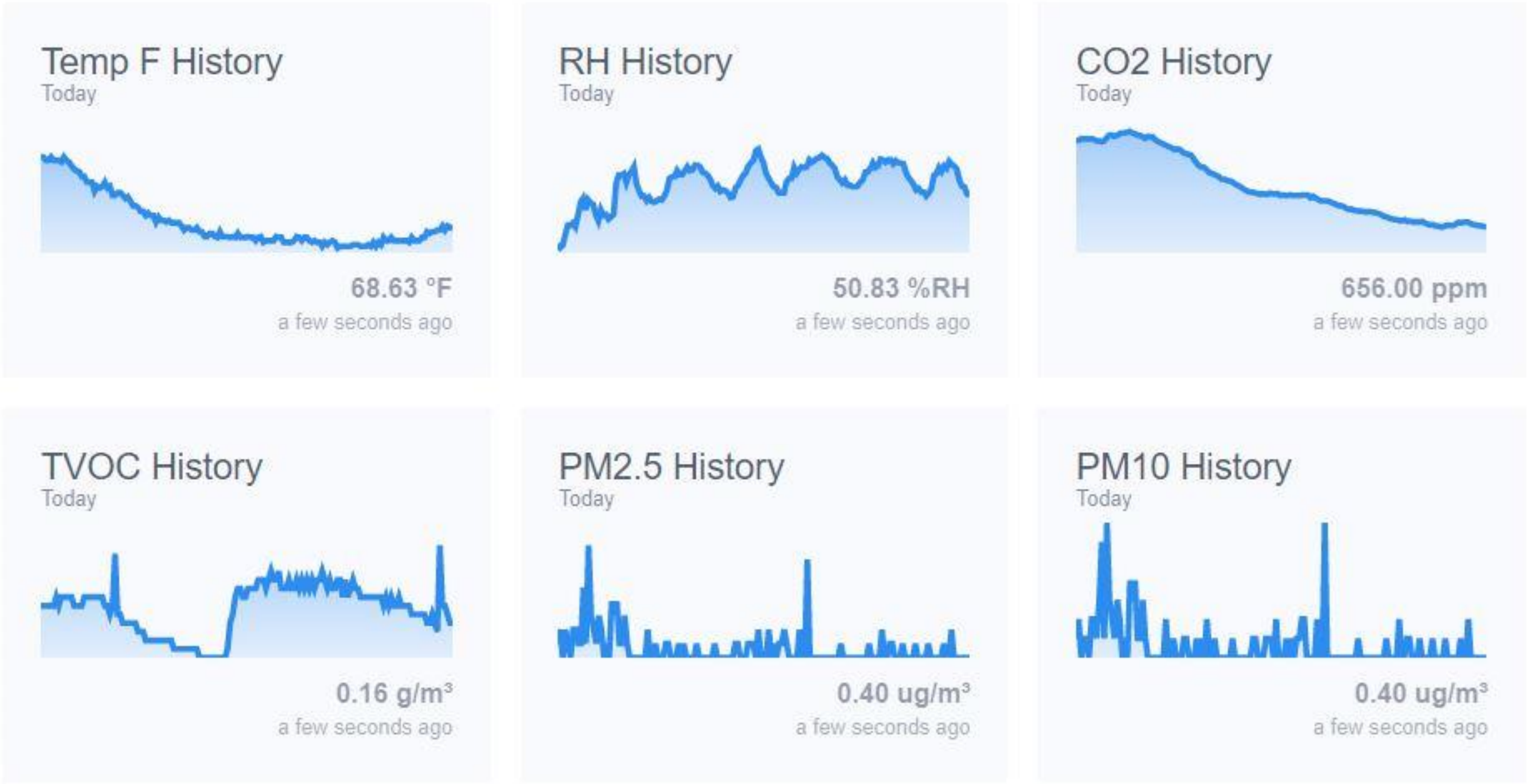
25
20
15
10
5
0

Leon Johnson

Data Overview

Eric Grogans

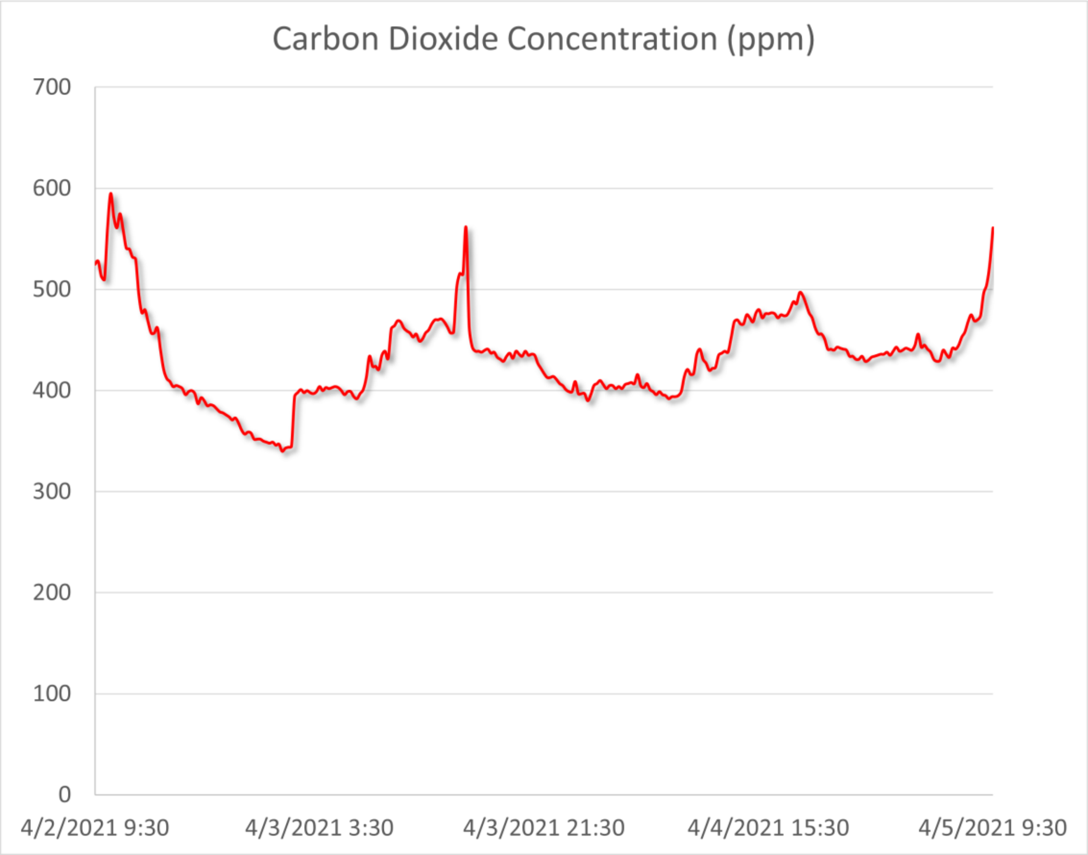
Data Display



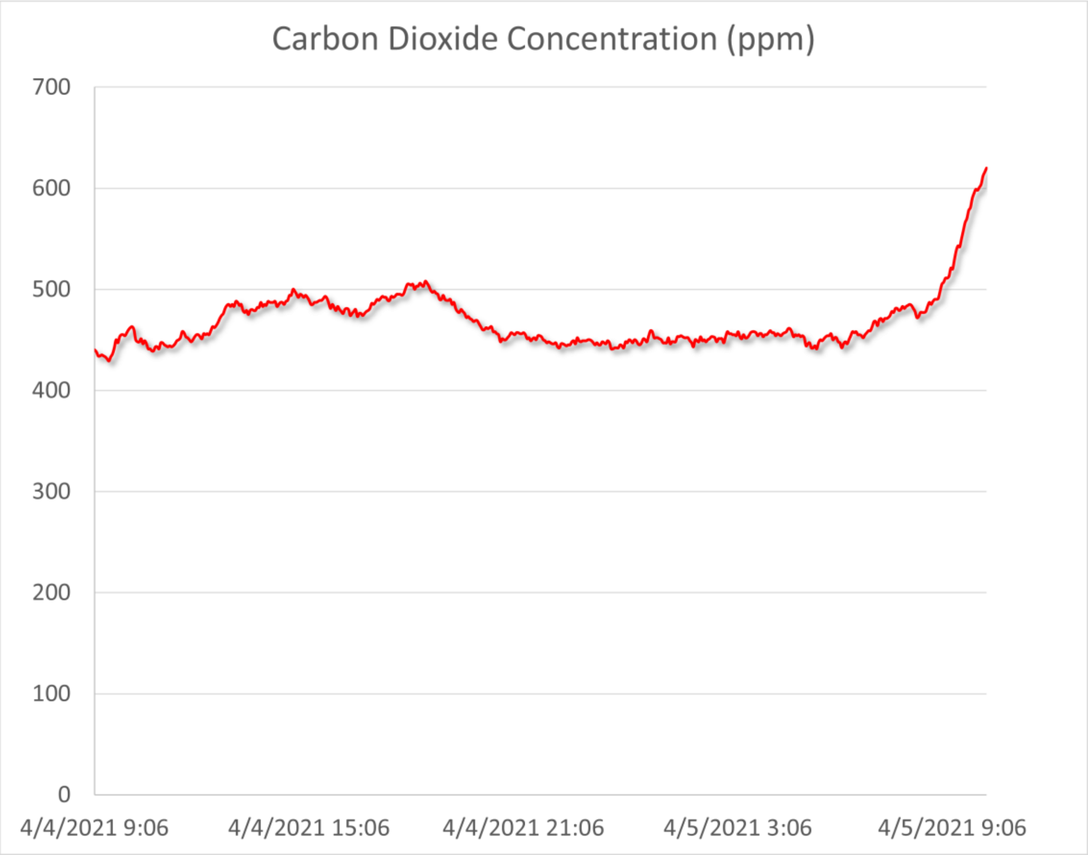
Eric Grogans

Long and Short-Term Data

Long-Term Data



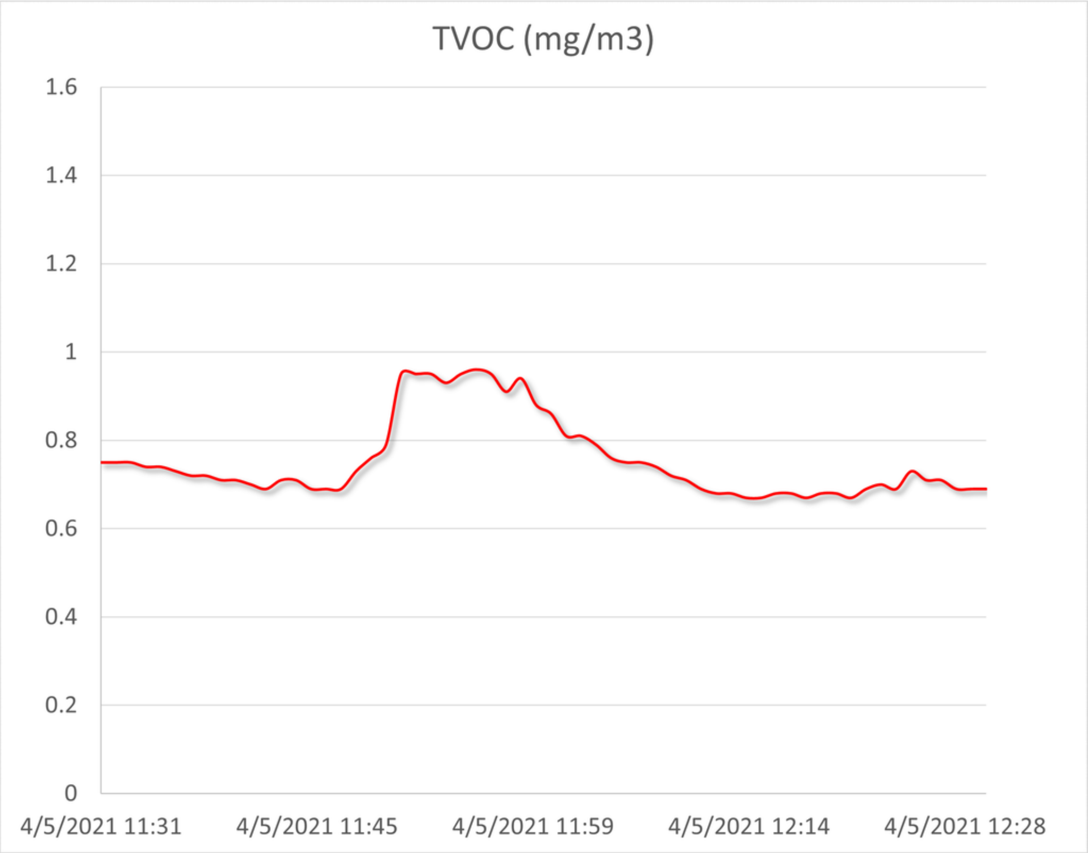
Short-Term Data



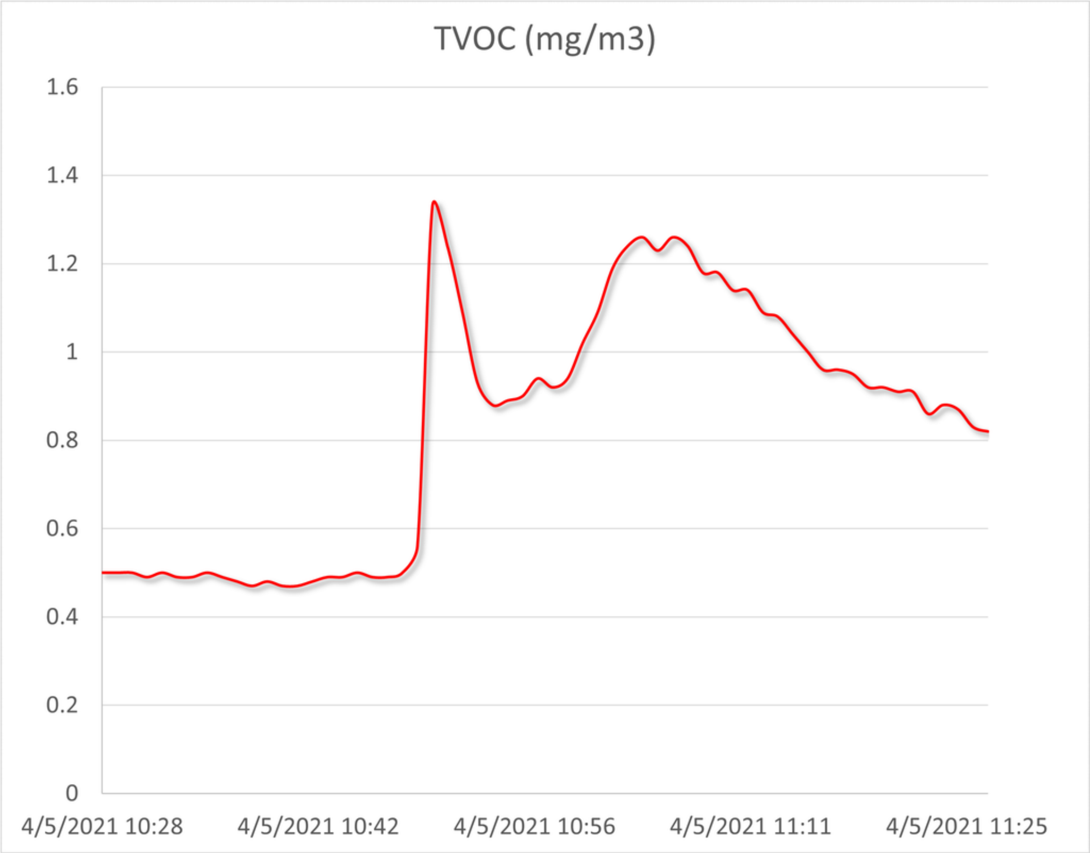
Eric Grogans

3D Printing

No 3D printing



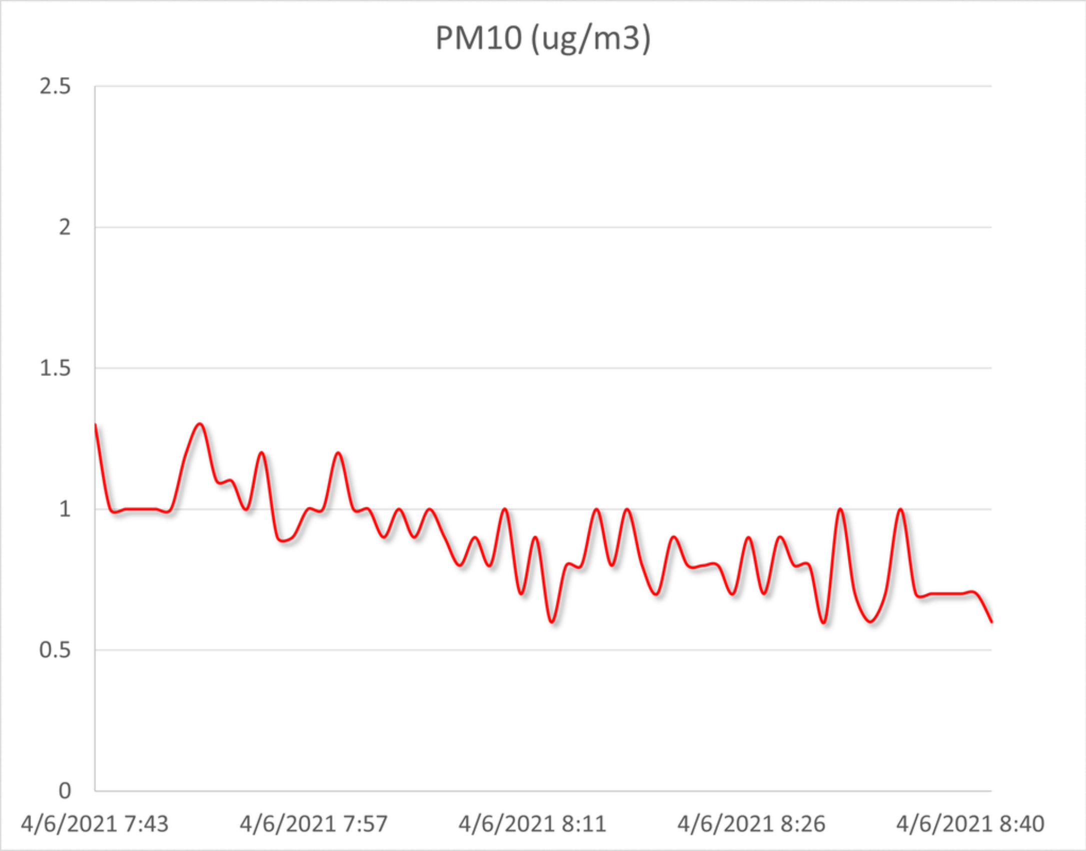
3D Printing



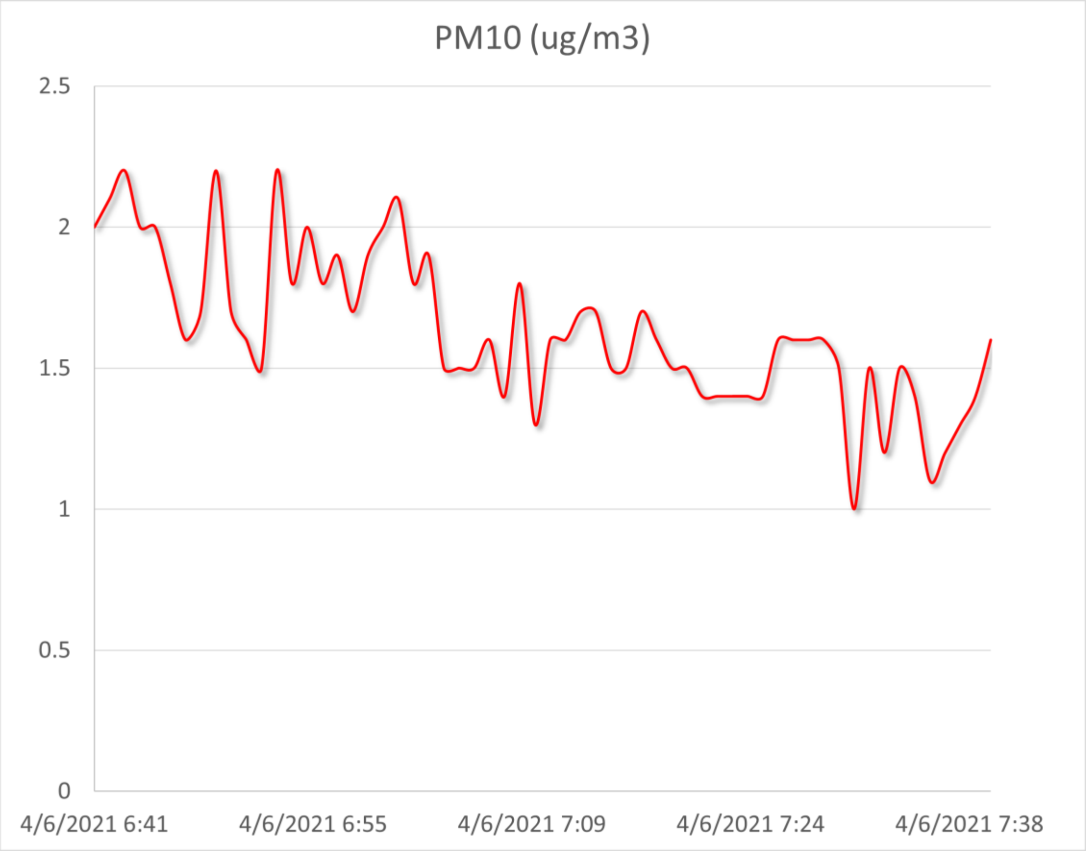
Eric Grogans

Constant vs Intermittent Purification

Constant Purification



Intermittent Purification



Eric Grogans

Future work

Complete Tests

- Complete tests in Senior Design Lab
- Run tests in other locations

Leon Johnson

Future work

Complete Tests

- Complete tests in Senior Design Lab
- Run tests in other locations

Analyze Data

- Process data gathered during tests
- Create simple and attractive graphics to display in testing locations

Leon Johnson

Future work

Complete Tests

- Complete tests in Senior Design Lab
- Run tests in other locations

Analyze Data

- Process data gathered during tests
- Create simple and attractive graphics to display in testing locations

Validate Design

- Check the design meets the described targets and metrics

Leon Johnson

Lessons Learned

- The ability to apply engineering skills across disciplines
- Building systems engineering skills
- Gained knowledge of technical simulation software
- Improved research skills
- Developed presentation skills
- Increased productivity through consistent work
- The importance maintaining good relationships with suppliers

Razhan Matipano

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

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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	D a t u m	+	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	D a t u m	+	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}

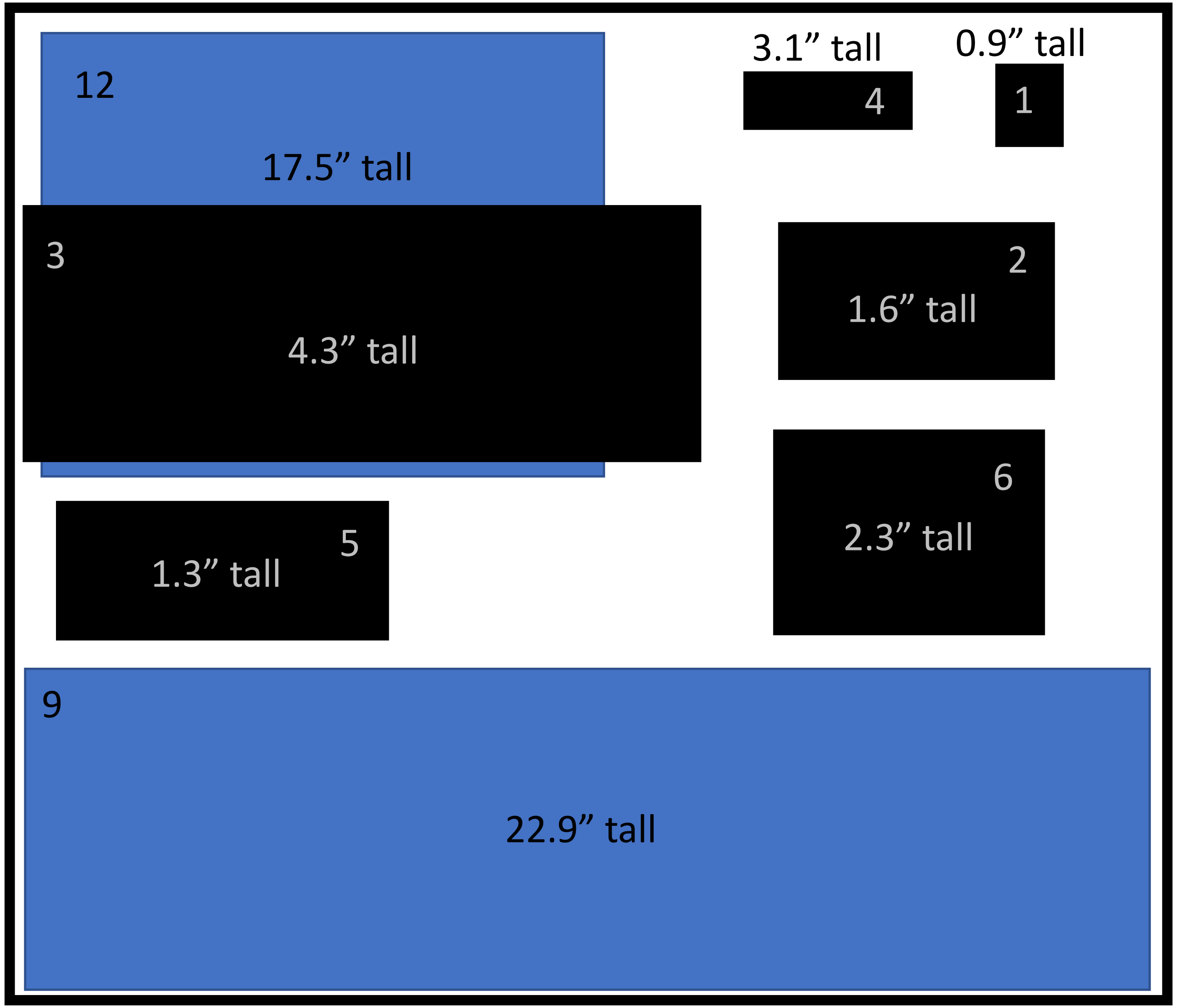
Criteria Comparison Matrix [C]

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

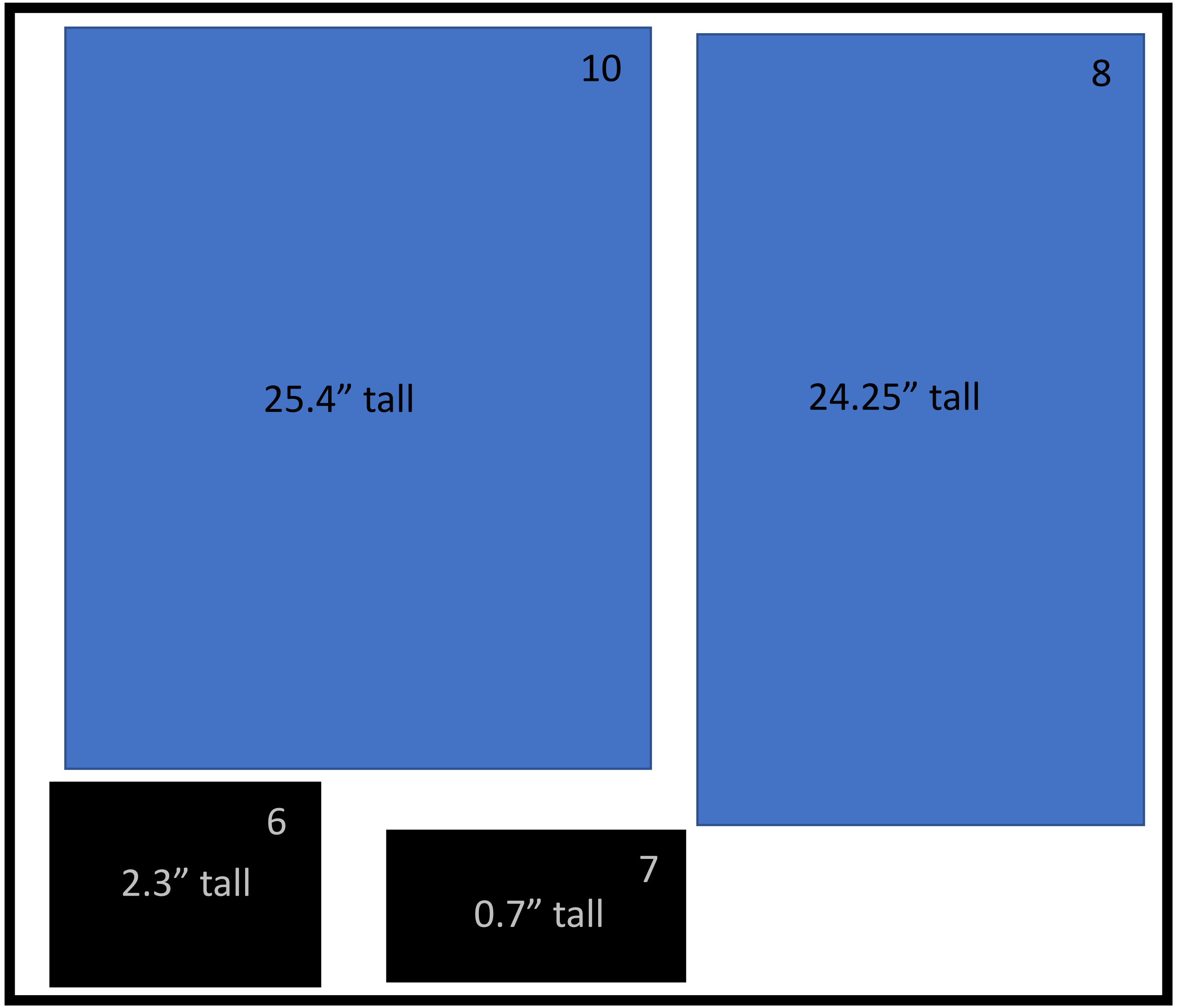
Development of Weighted Sum Vectors {Ws}													
Engineering Characteristics	Portability	Sense air Quality	Propeller Activation	Propeller Modulation	Purifier Activation	Purifier Modulation	Air Propulsion	Air Purification	Air Treatment	Filter Particulates	Air Humidification	Sanitize Contaminants	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



1	HPM Series PM2.5 Particulate Matter Sensor
2	BW Ultra Multi-Gas Detector
3	IntelliDox Docking Station
4	Honeywell Humidity Monitor With Digital Display
5	Anemometer
6	ComfortPoint Open Controller
7	CT60 Mobile Computer
8	Honeywell Professional Series True HEPA Air Purifier
9	Honeywell TurboForce Floor Fan
10	Honeywell 70-Pint Energy Star Dehumidifier
11	Honeywell UV Cool Moisture Germ Free Humidifier

- Lower Cabinet: Inside: 21 x 24 1/2 x 25 1/2" (L x W x H)
- 3.5 scale
- All dimensions in inches



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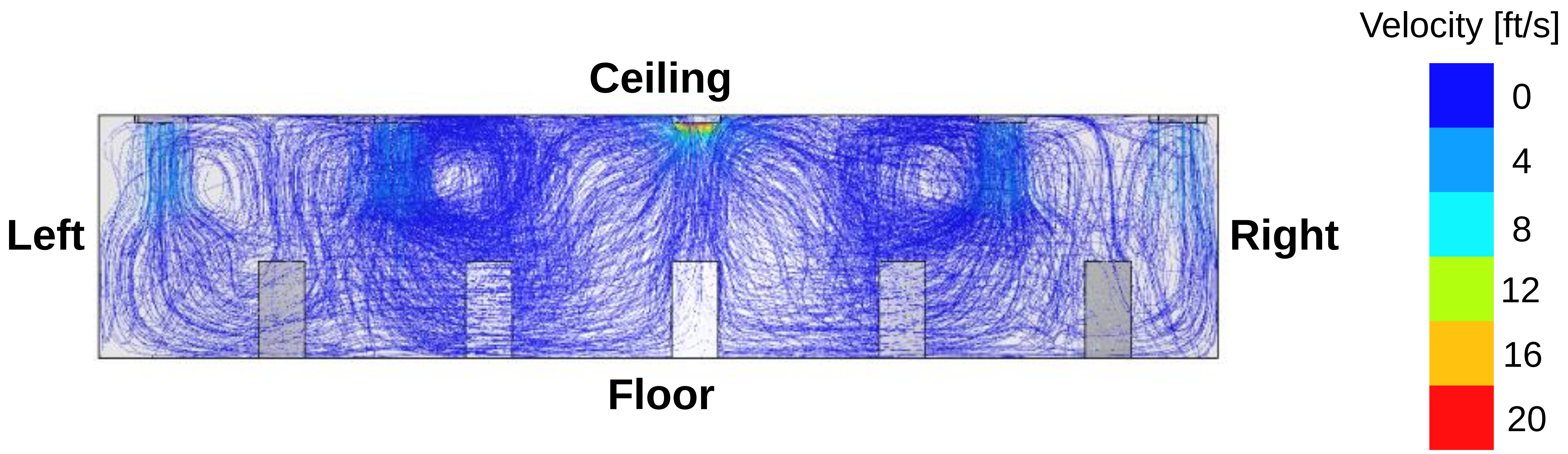
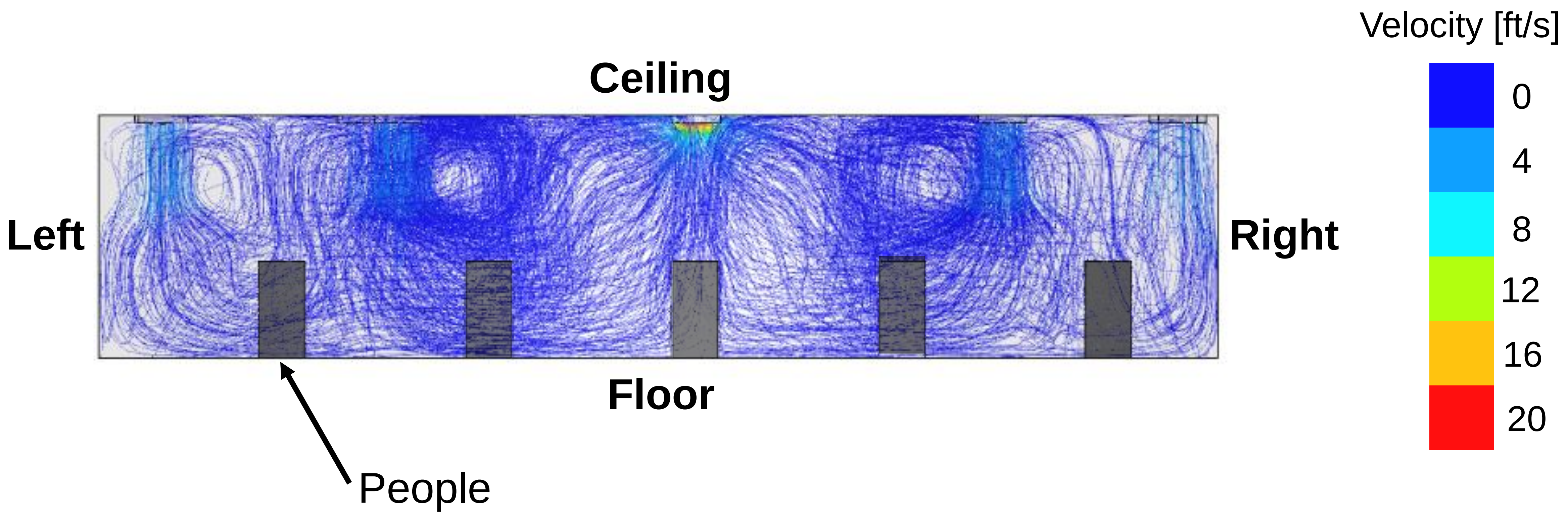
- Lower Cabinet: Inside: 21 x 24 1/2 x 25 1/2" (L x W x H)
- 3.5 scale
- All dimensions in inches

Simulation – Back View



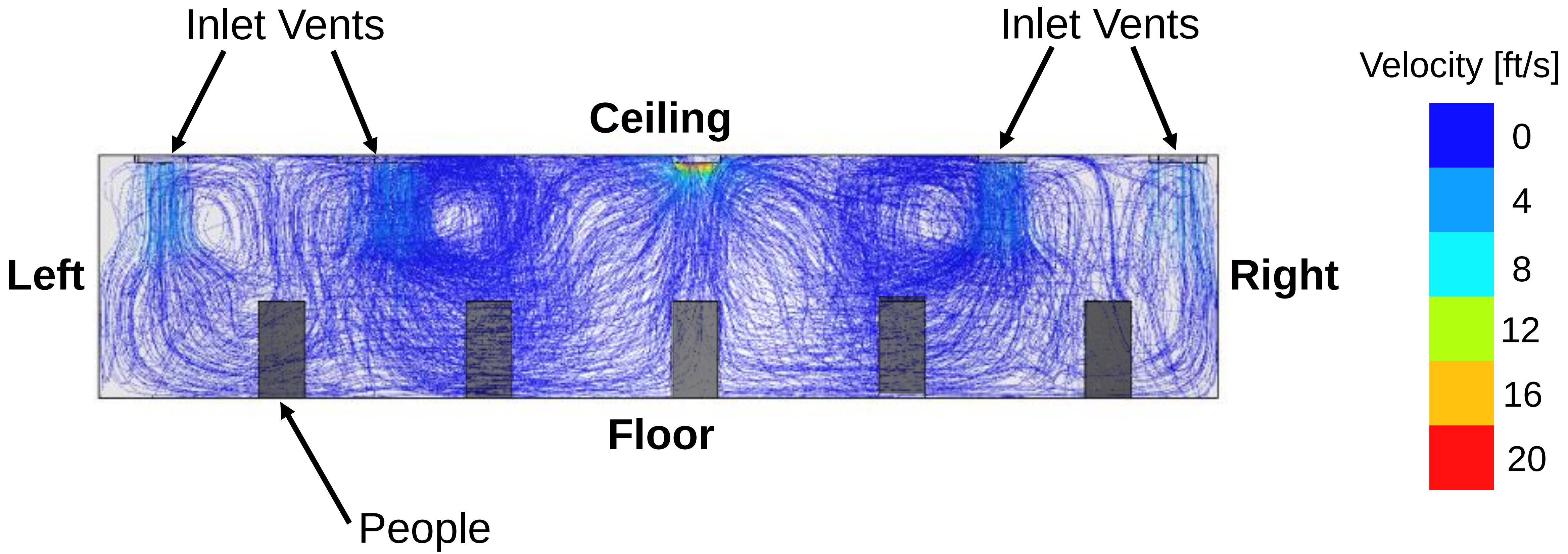
Leon Johnson

Simulation – Back View



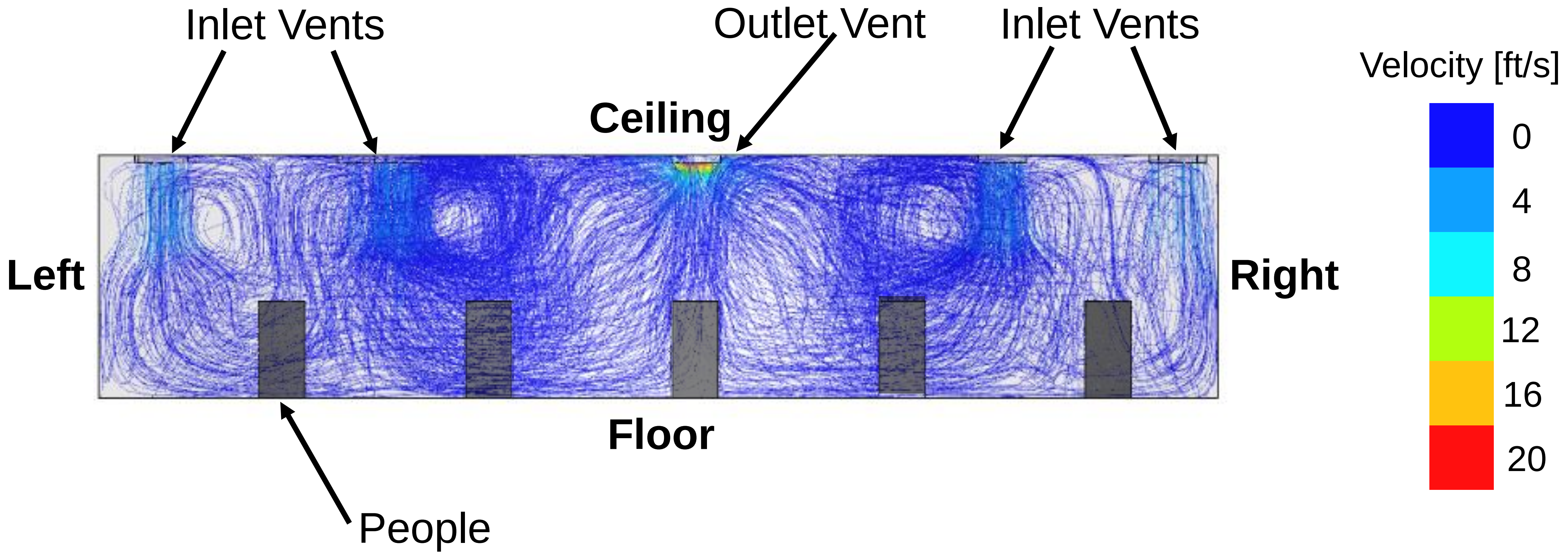
Leon Johnson

Simulation – Back View



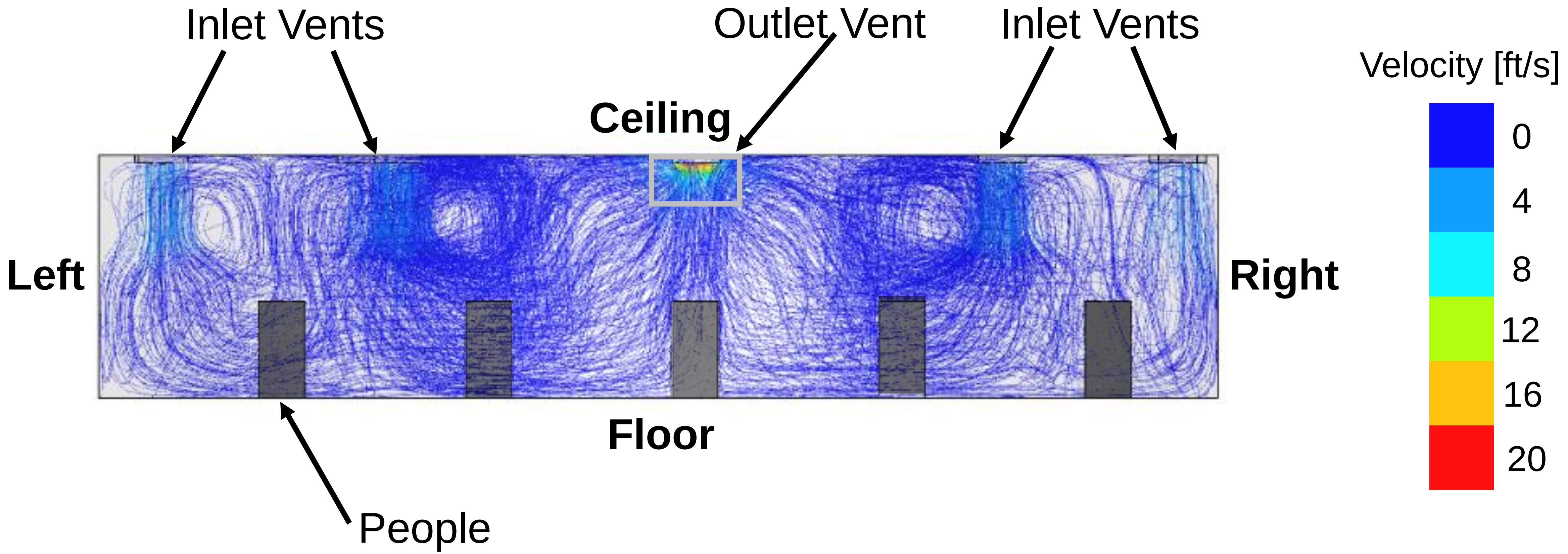
Leon Johnson

Simulation – Back View



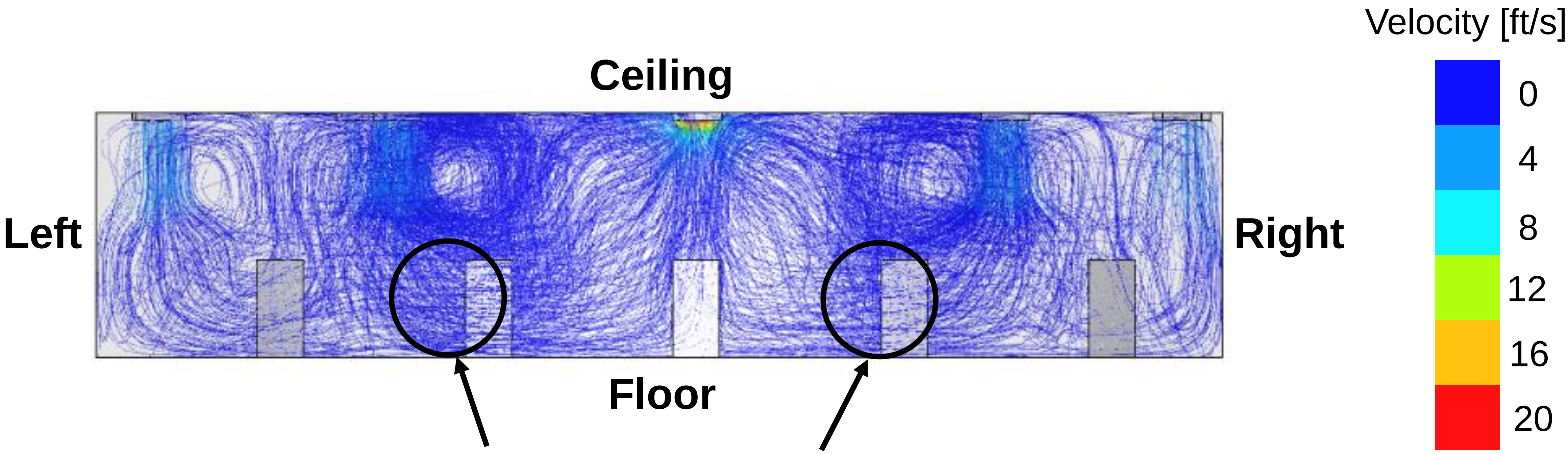
Leon Johnson

Simulation – Back View



Leon Johnson

Simulation – Back View



Place air purifiers and other cleaning devices in high airflow areas at ground level

Leon Johnson