

VENTILATE

TO OPEN AMERICA

WHY *VENTILATION* IS KEY TO GETTING BACK TO NORMAL



April 20, 2021

REDUCING TRANSMISSION OF COVID-19

There are two current strategies:

1. Reducing direct contact: person-to-person and from surfaces via sanitation (less and less important every day) and social distancing;
2. Reducing exhaled droplet spread via distancing and masking

There's a *third* strategy that's been largely overlooked, the one that addresses airborne hazards.

DIRECTIONAL VENTILATION

The key to reducing airborne hazards is *Directional Ventilation (DV)*, also known as *Displacement Ventilation*.

In this presentation, I will explain:

- How current ventilation systems supply air to indoor spaces and how they *fail to reduce airborne hazards* in those spaces.
- Some common ventilation misconceptions.
- How current ventilation systems can be improved with DV.
- What you can do to help.

We are trying to create a general awareness of ventilation shortfalls and then to get America open again!

WHO IS DRENNEN ENGINEERING?

- I'm John Drennen, Jr. PE, president of Drennen Engineering, inc in Windsor, CT. My experience includes 14-years R&D and 20-years engineering consulting related to analysis and modification of particle-laden internal flow patterns in fossil-fired power generation equipment.
- This expertise has now been applied to demonstrate the dangers of conventional ventilation practices in the spread of hazardous particles for both indoor and outdoor settings and then to identify solutions to reduce those hazards.
- We offer consulting services related to particle-laden internal flows, helping to increase occupancy and survivability in your space.
- Please visit our website <https://drennenengineering.com/> for more information, including videos, a ventilation IQ test, and more.

HOW DO CURRENT VENTILATION SYSTEMS WORK?

The prevalent indoor ventilation system uses a top-down *mixing* approach that supplies air from *ceiling* diffusers. Air is distributed across the room to maintain comfort; temperature and humidity at a desired setpoint.

Typical air supply diffusers and return grating are shown here.

These systems are designed to mix air in the space to maintain uniform conditions in the occupied zone. This means, *airborne aerosols exhaled by the occupants are thoroughly mixed across the space as well.*



WHAT'S WRONG WITH CURRENT VENTILATION SYSTEMS?

- As occupancy increases, exhaled aerosol increases and reaches a steady concentration in a few minutes. Visualize everyone smoking in a room. In just a few minutes, a uniform haze would fill the room, changing as smoke sources were added or removed.
- Due to the mixing nature of air flow patterns, *no amount of distancing, filtration, and/or barriers in the space would reduce exposure to aerosols (smoke) generated in the room.*
- No amount of air conditioning (cleaning) would change the circulation of airborne aerosols because of air flow patterns established by *Mixed Ventilation (MV)*.
- The collective “pandephobia” regarding indoor spaces reflects an inherent understanding that there is some danger lurking in the space, hovering about the occupants.
- Professional HVAC organizations and health associations have not done their part to educate the public on this topic or to lead the charge to change *Mixed Ventilation (MV)* to less mixed *Directional Ventilation (DV)*.



THE CDC NOW RECOMMENDS *DIRECTIONAL VENTILATION* COVID-19 CDC UPDATE, MARCH 23, 2021*



Regarding ventilation in buildings, the CDC now says:

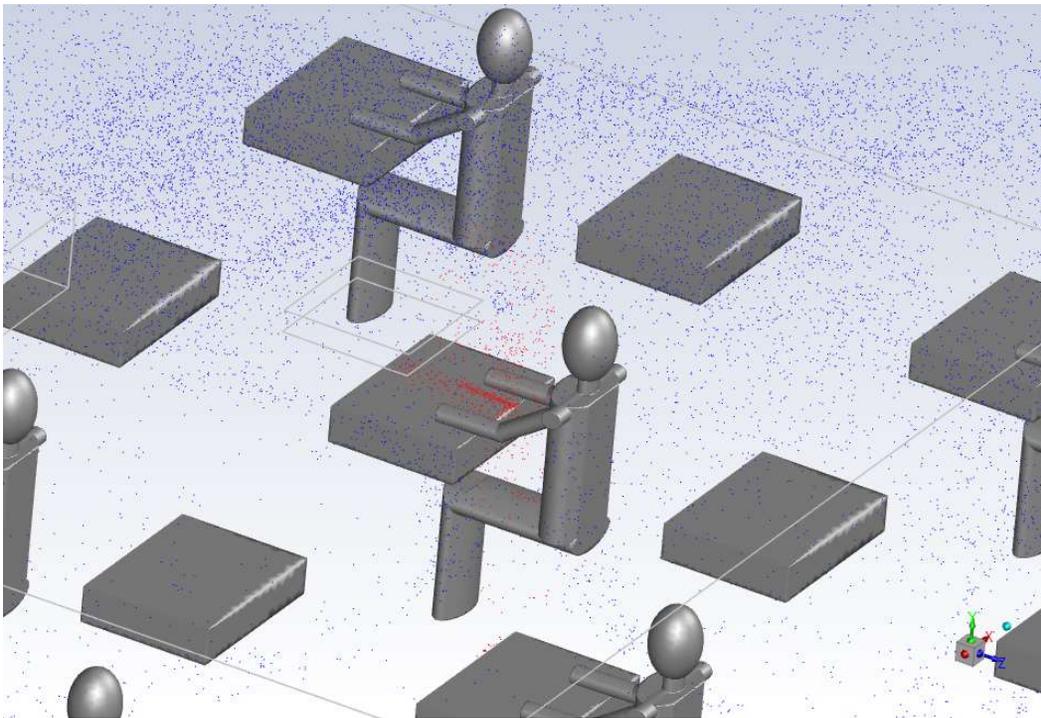
Generate clean-to-less-clean air movement by evaluating and repositioning as necessary, the supply louvers, exhaust air grilles, and/or damper settings.

- This update is coincident with recommendations from the American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE) in their Position Document on Infectious Aerosols published April 14, 2020.
- Unfortunately, other than making general recommendations, neither the CDC nor ASHRAE provides guidance on how to accomplish this or how to measure effectiveness. Neither group is leading the ventilation discussion.

* <https://www.cdc.gov/coronavirus/2019-ncov/community/ventilation.html#print>>
[Search for 'generate']

A COMPUTER SIMULATION OF AN INDOOR SPACE WITH AIRBORNE PARTICLE MOVEMENT

Please visit drennenengineering.com/airborne-particles/ for a video that shows a computer simulation of airborne particle movement in an indoor setting. It demonstrates the dangers posed by conventional ventilation practices relative to the movement of those particles across the space.



<https://tinyurl.com/3azam326>

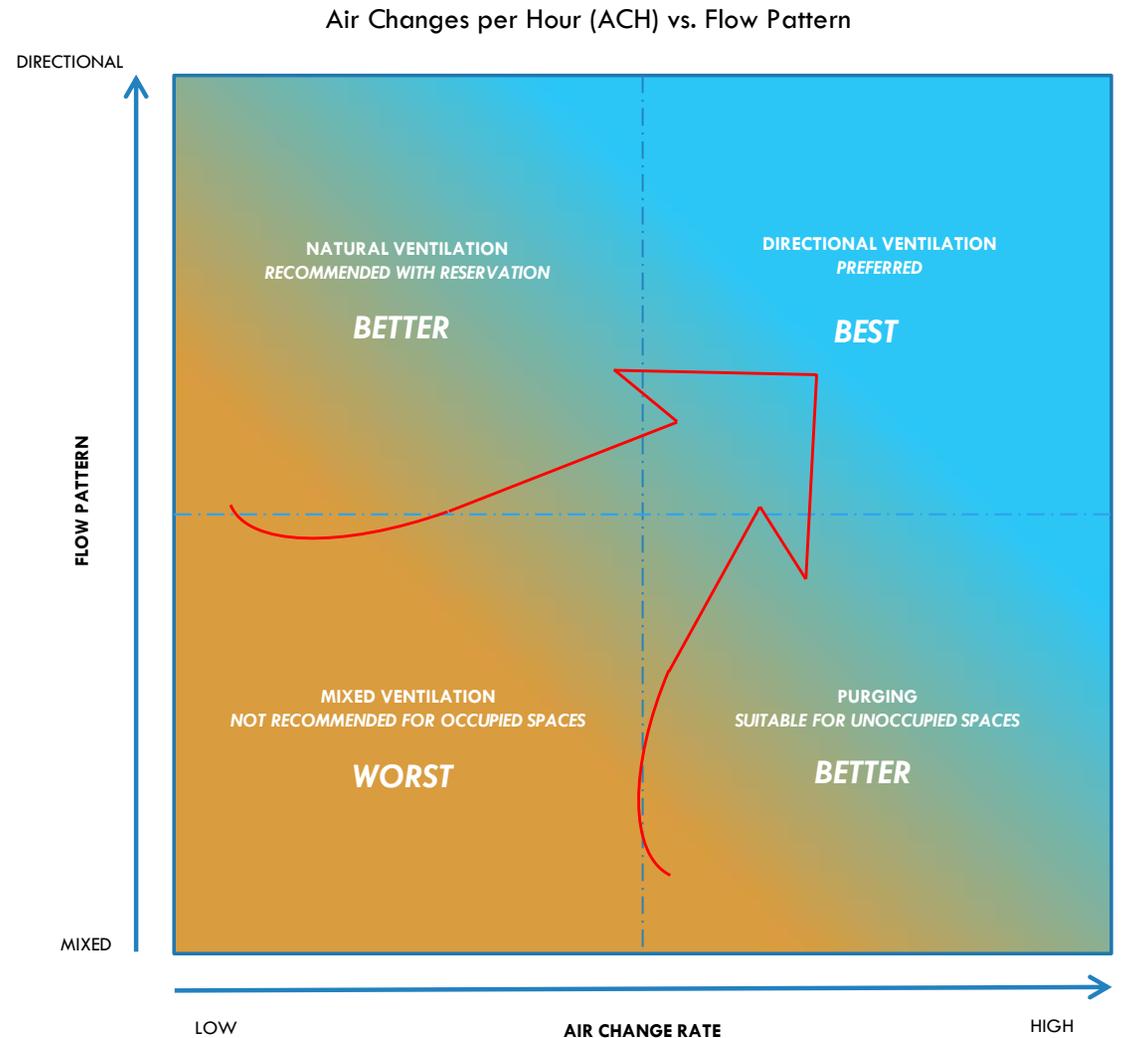
COMMON VENTILATION MISCONCEPTIONS

None of these assertions are true:

- **Increasing Air Change Rate (ACH) reduces indoor hazards** – In an occupied space, increasing flow into the space increases the rate at which airborne hazards are distributed across the room. In an unoccupied room, more air can reduce purge time, usually hours once the occupants leave.
- **100% fresh air reduces indoor hazards** – The amount of fresh or cleaned air admitted to a space in a conventional top-down mixing system does nothing to change mixing in the space.
- **Negative pressure rooms are safer than pressurized rooms** – Air flow pattern in a room is determined by the placement of supply and return ducts, not by relative pressure. Negative pressure rooms can prevent airborne hazards from being blown into a hallway when the door is opened or through the gap at the bottom of the door.
- **Natural ventilation is better than mixed ventilation** – This is not a reliable or consistent method to ventilate a space. Occupant exposure varies with source location and breeze direction.
- **In-room air cleaners are effective** – Free standing air cleaners increase mixing in the space due to fan-driven flow, typically from the bottom of the room upwards. This flow pattern brings the most polluted air from the upper part of the room back down into the occupied zone. While the room is occupied, the marginal cleaning benefit is overshadowed by the dangers associated with increased mixing.

VENTILATION RECOMMENDATIONS

- Directional ventilation patterns are needed to improve ventilation efficiency and reduce airborne hazards. The graph illustrates the worst, better, and best scenarios for ventilation.
- Rearranging air supply and return location could be accomplished with minor equipment changes in many spaces.
- Custom solutions can be created with modeling and testing for any space, inside or outside.
- Please see Appendices for additional information.



HOW CAN WE IMPROVE VENTILATION SYSTEMS?

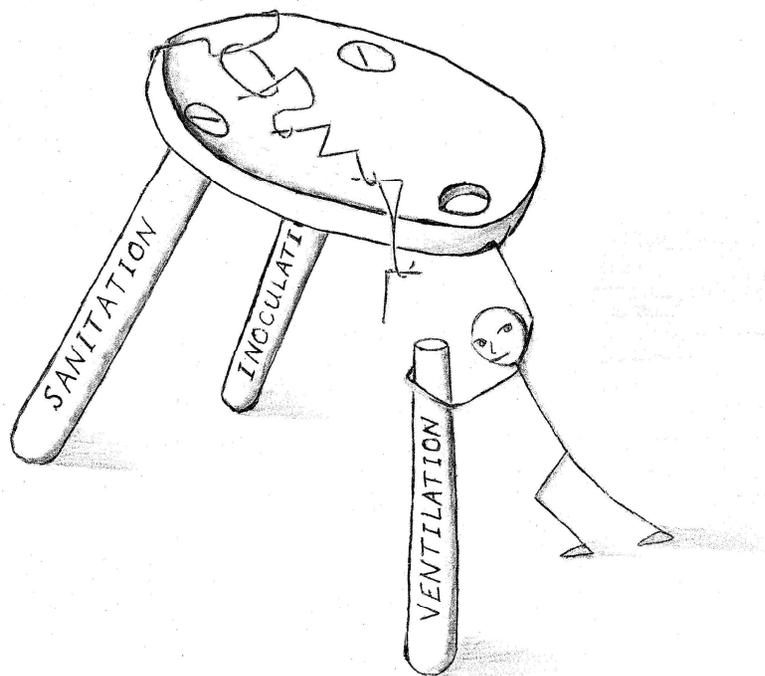
- Add air into the occupied zone *horizontally* as open windows do in natural ventilation patterns, rather than from the top of the room. The general inward air flow pattern should be horizontal and then *up* to the return (exhaust) ducts and *out* to conditioning equipment. *That is technically known as Displacement Ventilation (DV).*
- Centrally locate return air outlets at the top of the room or in the ceiling.
- Add personalized air supply and exhaust as needed to increase ventilation efficiency in specific occupied areas.
- Use expert modeling and testing to select and place ventilation equipment for spaces based on occupancy and use.

Note that these are simplified recommendations. The overall goal is to reduce mixing and increase ventilation efficiency.

HOW CAN YOU IMPLEMENT BETTER VENTILATION?

- If the spaces you use and visit have top-down *mixed* ventilation, contact the facilities manager and ask for an evaluation of the ventilation system; then lobby for changes that decrease mixing and increase ventilation efficiency.
- Ask an HVAC specialist to evaluate your space qualitatively (via visualization) and quantitatively (through modeling and/or testing) with a report of the capability of the HVAC system to remove airborne pollution and its ventilation efficiency.
- Begin a discussion with management on methods to reduce mixing patterns and identify changes or supplemental HVAC components to provide directional flow.
Prioritize occupant safety and installation speed over aesthetics and comfort.
- Show this document to managers or the owner and ask: “What about this? Can you do these things to make our spaces safer?”
- Select a contractor that is open-minded, enthusiastic, and forward-looking to help define features of the new normal that reduce airborne hazards and increase survivability in indoor and outdoor spaces where you live, work, shop, eat, and play.

THE NEXT WAVE: VIRAL OR VENTILATION?



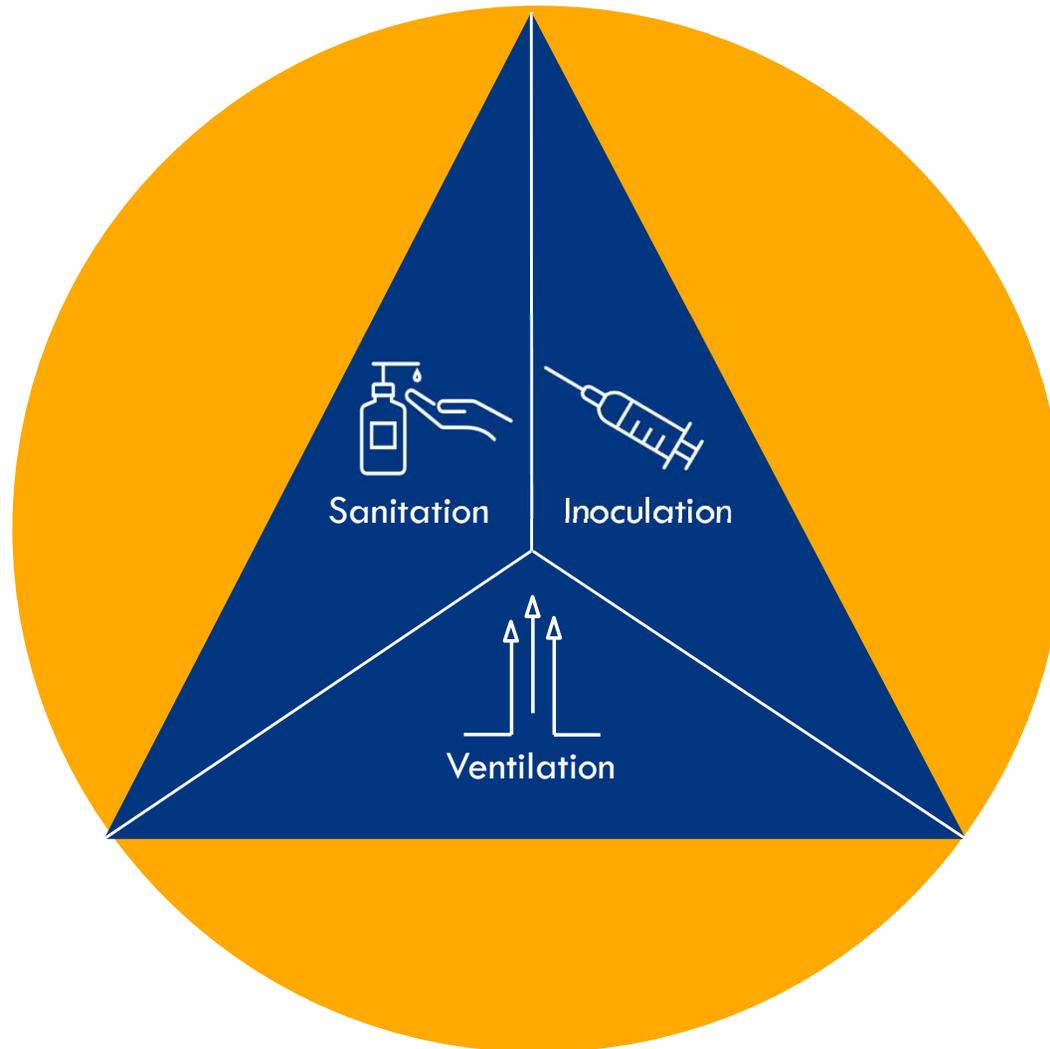
[HTTPS://WWW.GOFUNDME.COM](https://www.gofundme.com)

SEARCH FOR: *VENTILATE AND
OPEN AMERICA*

- Join the ventilation revolution and help develop long-term strategies to reduce threats posed by COVID-19, COVID-20, 21 α , 21 β , etc., and even seasonal flu viruses.
- Visit the GOFUNDME site to read my proposal for development of design tools and standards to establish ventilation methods that improve safety, survivability, and confidence in indoor spaces.
- Think about it: If you had the choice of being in a space with top-down mixed ventilation or directional ventilation, which place would you rather work in, shop in, eat in, etc.?

Help add the third leg and get to the new normal.

APPENDICES



Appendix 1

A Qualitative Demonstration *You Can Do*

Based on published literature, smoke particles, such as from cigarettes or incense sticks, have overlapping size and density distributions with virus particles and can therefore reproduce their movement aerodynamically.

In a normally occupied space such as a classroom, cafeteria, conference room, office, lobby, etc., light a smoke-generating device (a cigarette, a scented candle) and measure how long it takes to detect the odor across the space. In most spaces, it will be less than five minutes due to efficient mixing. (You could also use a fragrance mister for this experiment such as a room freshener. The suggested smoke generators emit continuously for 5-10 minutes or more and better represent a space that remains occupied. Periodic misting can achieve a similar concentration.)

You may be surprised at the mixing speed – even if you are wearing a mask. You might then question the effectiveness of a mask, in both directions. Do you ever fog up your glasses with a mask on? Well, the answer indicates that the smallest, and possibly most dangerous aerosols can be emitted and inhaled while wearing ill fitted masks.

In the last quarter of the 20th century, following much study and discussion, *Secondhand Smoke* was declared a health hazard. The solution was to remove the source, i.e., no smoking inside. In the first quarter of the 21st century, an airborne spread pathogen was declared a health hazard. The solution was to remove the source, i.e., no people inside.

In both cases, there was/is a failure to address the contribution of ventilation to the spread of *Secondhand Smoke*/exhaled aerosols. If ventilation efficiencies had been improved then, we would still be inside!

Thirdhand Smoke describes airborne particles that electrostatically attach to surfaces in the space that can be resuspended by air currents and produce the familiar odors detected hours and days after the source have been removed. Virus particles can behave in a similar fashion.

Appendix 2

Business Owners: Something to Visualize

- You've changed the air flow pattern in your space from *mixing* to *directional* (via *displacement, purging, or similar*).
- When you walk through the space, the likelihood that you would be breathing someone else's spittle (exhaled aerosol) is significantly reduced.
- Your employees feel safer working in the space ... because they are.
- Your customers feel safer in your space ... because they are.
- Your customers tell other people and they come because it's a safer option.
- The media calls and wants to see what you've done ... it goes national.
- If you're a restaurant, your reservation book is filled.
- If you're a property manager, your spaces are filled.
- The governor says you can increase capacity to 75%, and then 100%.
- No infections traced back to your space ... "pandephobia" decreases ... normal increases.
- People are coming from all over the country and world to experience the new normal.
- You are on the leading edge.

It's time to make changes. Start now.