Airborne infection and breathing walls

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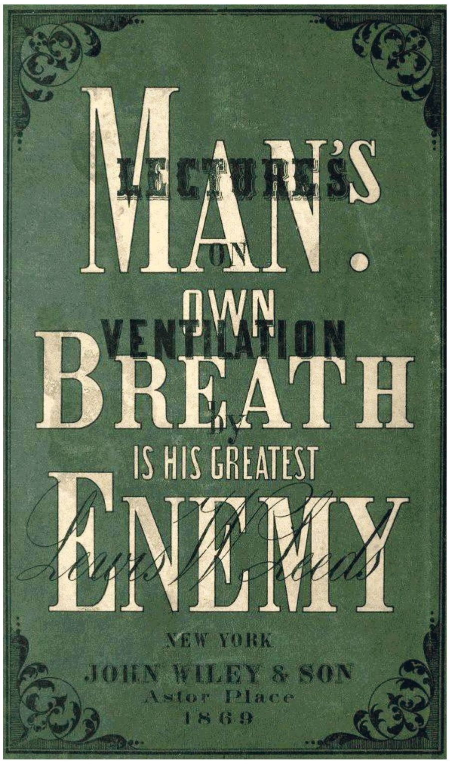
Airborne Infection and Breathing Walls
Didem Ekici

Variations on miasma theory dominated medical discourse throughout most of the nineteenth century, which witnessed six cholera pandemics and long-standing epidemic threats such as tuberculosis. Some versions of the theory held that epidemics were caused by noxious gas emanating from rotting organic matter; others related miasma to specific kinds of climate. The miasma was imagined existing in the foul-smelling air of streets as well as domestic spaces in the nineteenth-century city. Some physicians warned that the vitiated air in badly ventilated, packed rooms in overcrowded housing was more deadly than the foul air outdoors. As the American physician Lewis Leeds proclaimed in a public lecture in 1866, “it is not in the external atmosphere that we must look for the greatest impurities, but it is in our own houses that the blighting, withering curse of foul air is to be found. We are thus led to the conclusion that our own breath is our greatest enemy.” Miasma theory, coupled with the problem of overcrowded housing, led to the emergence of air as a dynamic design element in nineteenth-century efforts to mitigate the airborne transmission of disease, culminating in ventilation technologies. Hygiene manuals increasingly discussed natural and forced ventilation methods to alleviate the health hazards of expired air. Indoor air was cast as a dynamic, everchanging entity. Contemporary ventilation studies represented the void inside buildings as filled with air currents moving between inside and outside, and expired air and gases emitted by bodies that spread infectious diseases.

The perceived hazards of miasma and expired air in relation to infectious diseases led to experimental investigations of indoor air. In the second half of the nineteenth century, German physician Max von Pettenkofer (1818–1901) made several seminal contributions to indoor air sciences. His studies quantified indoor air quality and turned the air into a tangible design criterion. He established how carbon dioxide could be used as the main indicator of indoor air quality when determining the required ventilation rate in a building for a person to remain healthy and comfortable. This indicator is still in use.

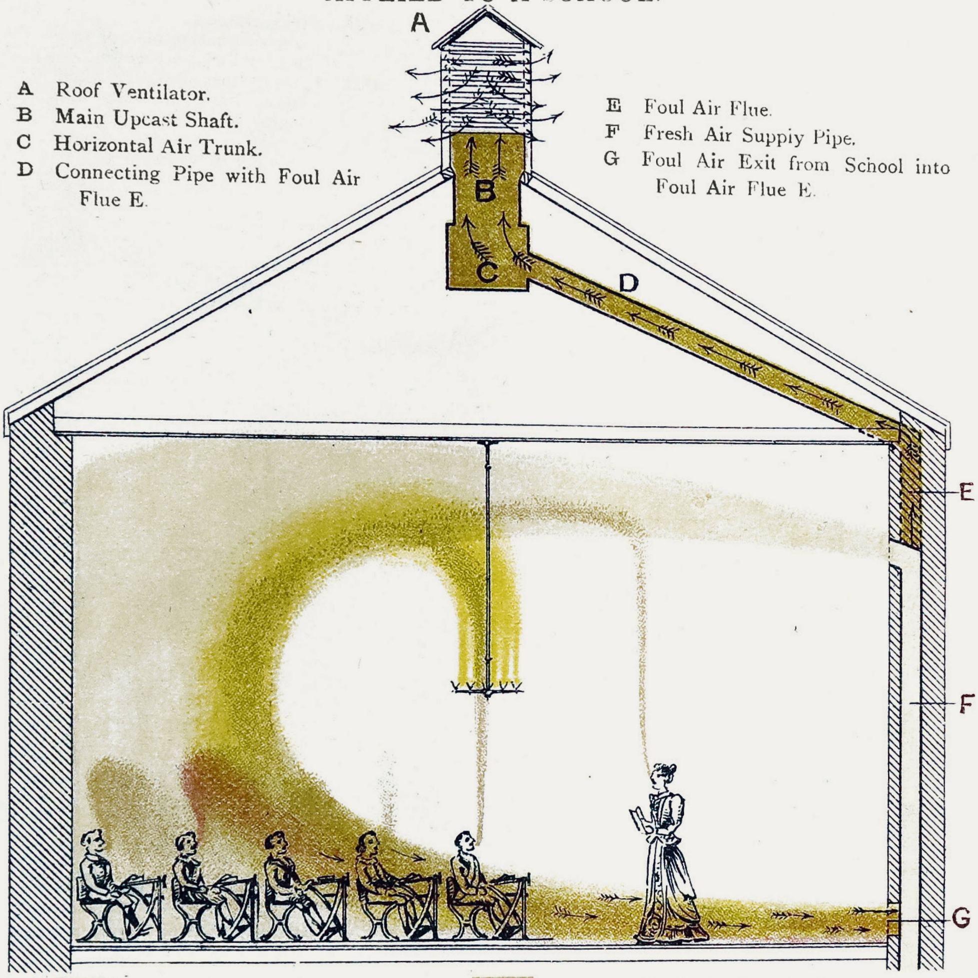


The agency of the miasma was dispelled after 1880 by bacteriologist and physician Robert Koch's germ theory of disease, which stated specific germs, not miasma, caused specific diseases. The miasma theory, however, persisted in popular imagination long after the scientific consensus behind it had crumbled. In the late 1800s, Pettenkofer and Koch were at the heart of the scientific debate over the causes of cholera. One of the most recalcitrant defenders of miasma theory, Pettenkofer incorrectly argued that the cholera germ became infectious only when it became cholera miasma after prolonged contact with the soil. To prove his thesis, in 1892, he drank a suspension of cholera bacteria and, remarkably, did not become seriously ill. This notorious episode aside, Pettenkofer's study of environmental factors had a significant influence on both public health and architecture. His scientific method of mapping everyday environments formed the basis of modern hygiene. By monitoring the exchange between the human body and built space, experimental hygiene rendered metabolic functions, such as breathing, architectural issues.

The requirement of consistent ventilation involved a rethinking of the spatial boundaries of buildings. Pettenkofer saw walls no longer as solid barriers that protected inhabitants from the elements but as a porous interface that mediated exchange between

the interior and the exterior. He equated walls with skin in their permeability. Porous external walls were necessary to facilitate fresh air access and to prevent humidity in the house. By advocating permeability, Pettenkofer challenged common views about the separation of the house's inside and outside. He believed that there was no such thing as self-contained architecture, and the house was inevitably part of the broader atmosphere.

"MECHANICAL VENTILATION ON THE LATERAL AND DOWNWARD PRINCIPLE, BY IMPULSION, OR THE PLENUM SYSTEM, APPLIED TO A SCHOOL.



A Roof Ventilator.
B Main Upcast Shaft.
C Horizontal Air Trunk.
D Connecting Pipe with Foul Air Flue E.

E Foul Air Flue.
F Fresh Air Supply Pipe.
G Foul Air Exit from School into Foul Air Flue E.

BLUE—Fresh air supply.
YELLOW—Products of combustion.
BROWN—Products of respiration.
RED—Products of respiration from infected scholar.

"'It is well known to sanitarians that such a mode of changing the air (downward ventilation) is inimical to health, being not only a direct cause, but a fruitful means of disseminating disease, as evidenced by the report issued by the Local Government Board, one town, where the schools are mechanically ventilated on the downdraught principle, being specially mentioned as the "chief focus" of the disease (influenza) in Scotland.'—*Local Government Journal* on Report to Parliament by the Local Government Board."

HOW INFECTION IS SPREAD.

"The report on the influenza epidemic presented to Parliament by the Local Government Board indicates the extreme importance of proper ventilation—especially in schools—which is pronounced to be the only real safeguard against that disease.

"The statistics given point to one town, where the schools are mechanically ventilated on the downdraught principle, as being the 'chief focus' of the disease in Scotland. So far as the children in the schools are concerned this is easily accounted for, as the warm, infected air expelled from the lungs is returned by the descending current, and is not only reinhaled, but is also breathed by the other scholars. This is how infection is spread."—*Local Government Journal.*

This change in the status of the building's periphery signaled a profound shift in the understanding of architecture. As hygiene conceived the individual to be embedded in their environment, building professionals understood architecture as the extension that mediated the exchange with the environment. Environmental technologies aided and extended the metabolic functions of the body into the building, giving a new lease of life to the analogy between the human body and building. The dwelling came to be regarded as a type of porous skin that inhales the outdoor air and exhales the indoor air. Although Pettenkofer's hypothesis on the porosity of walls was scientifically discredited in the 1920s, it eventually contributed to the understanding of architecture as a permeable membrane and well-tempered space. The concept of "breathing walls" has endured until the present day, signifying both material qualities and ventilation techniques.

In the first decades of the twenty-first century, one might think the relationship between airborne infection and indoor ventilation to be settled. However, the coronavirus pandemic has exposed a rift between those scientists who warned against the spread of COVID-19 through aerosols and the World Health Organization, which insisted on more definitive proof of airborne transmission before it revised its guidelines. The World Health Organization's doctrine was that direct contact caused infection, not lingering airborne aerosols. Its initial skepticism regarding aerosol transmission goes back to the rejection of the miasma theory in the late nineteenth century. Modern medicine exorcized the ghosts of the miasma theory by requiring a very high level of proof to accept any disease as airborne. Critics have pointed out that the de-prioritization of aerosol transmission has resulted in the alarming lack of emphasis on indoor ventilation in official guidance early in the pandemic. Miasmas, it turns out, might not be meaningful on a molecular and biological level but are both real and, what is more, active from the perspective of public health.

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fig. 1 Book cover from Lewis Leeds, *Lectures on Ventilation by Lewis Leeds: Man's Own Breath is His Greatest Enemy* (New York: Wiley, 1869), based on a course delivered at the Franklin Institute, Philadelphia (1866–1867)/Quotation from page 7

fig. 2 Illustration of air currents in a room, from Lewis Leeds, *Lectures on Ventilation*, facing p. 26
Source: Deutsches Museum Bibliothek, Munich

fig. 3 "Natural System of Ventilation ... applied to Schoolrooms," Plate VII, in Robert Boyle, *The Boyle System of Ventilation*, trade cat. (London: Robert Boyle & Son, ca. 1900), 174
Source: Cadbury Research Library, Special Collections, University of Birmingham