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SUSTAINABLE LABS AT SCRANTON & RICE

BENEFITS OF RENTAL TECHNOLOGY

THE IMPORTANCE OF GOOD VENTILATION

MAGICAL SCIENCE SPACE FOR NEURO-SCIENCE STUDENTS

STRATEGIC PROGRAMMING

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SUSTAINABLE FACILITIES: VENTILATION TECHNOLOGY

by Hilary Moreno

Every Breath You Take

It's easy to see when a broken dorm window needs to be replaced or a leaky faucet in the science lab repaired, but things we can't see are compromising the physical and mental health of students, staff, and faculty. Good ventilation is the key to maintaining a healthy balance.

The Air We Breathe

The air we breathe outside is composed of roughly 78% nitrogen, 21% oxygen, 1% argon, .03% carbon dioxide, and water vapor. Depending on the location, our air can also be filled with anything from ultrafine particulates from vehicle exhaust to influenza. Outside, natural air currents help move airborne contaminants along and dilute unhealthy concentrations of toxic fumes but inside, we are held captive to a multitude of harmful, microscopic invaders. Effective ventilation not only reduces the amount of physical ailments students and faculty may experience in a school year but also directly impacts overall mental performance.

The Clean Air Act was passed in the U.S. in 1963 and drastically reduced the amount of air pollution resulting from the burning of fossil fuels and vehicle emissions; however, indoor air quality (IAQ) was overlooked. With the recent introduction of green building certifications like the WELL Building Standard, which focuses on how successful a building is in maintaining the health and well-being of its occupants through the quality of air, water, nourishment, light, fitness, comfort, and mind, the importance of indoor air quality can no longer be disregarded.

According to Rob Goodfellow at Dynamic Air, the most successful combination of ventilation techniques to improve overall indoor air quality is the cleaning of recirculated indoor air as well as incoming ventilation air "through filtration systems with low static resistance, as opposed to dense high-efficiency traditional filters." Goodfellow suggests that universities should initially invest in air quality sensors to determine current contaminant levels and locations on campus to define the most efficient and effective ventilation solution for each building.

> Current ventilation technology combines high MERV performance with low static air pressure resistance and filters that last for years. This translates to reduced energy consumption, lower energy bills, greener campuses, smaller carbon footprints, and healthier students, faculty, and staff.

Physical Effects of Poor Indoor Air Quality

The Environmental Protection Agency (EPA) ranks indoor air pollution among the top five environmental public health risks citing that indoor air can be anywhere from two to five, to as much as 100 times, more polluted than outdoor air as shared in a current EPA report, *Why Indoor Air Quality is Important to Schools*.

In another recent EPA article, *Fundamentals of Indoor Air Quality of Buildings*, the EPA separates symptoms of poor air quality into four categories: acute effects, chronic effects, discomfort, and performance effects. These symptoms range from the temporary—headaches, itchy eyes, runny noses, irritated skin, coughing, fatigue, shortness of breath, dizziness, and nausea—to the chronic—liver disease, kidney damage, nervous-system failure, severe respiratory conditions, and cancer.

Studies, such as *Managing Asthma on the College Campus: Findings of a Texas Pilot Study* by Kevin P. Collins, Debra N. Weiss-Randall and Nicholas R. Henry in 2012, found that around 8.8% of college students suffer from asthma which can be triggered or worsened by exposure to mold in inadequately ventilated buildings. Other pollutants, like carbon monoxide, ozone, particulates, and volatile organic compounds (VOCs) come from everyday products such as industrial-strength cleansers and disinfectants, air fresheners, adhesives used in furniture, and paints as well as printers and copiers.

Cognitive Effects of Poor Indoor Air Quality

Outdoor air contains an average of 380 parts per million (ppm) of carbon dioxide. EPA guidelines recommend that carbon dioxide concentrations in classrooms be no higher than 1000 ppm. Unfortunately, classroom air, due to high-occupant density, has been shown to contain between 1,000-3,000 ppm of carbon dioxide which tends to spike throughout the day depending on the number of people in the room. At that level, multiple studies, such as one led by Fisk at Berkely Lab and another called The Strategic Management Simulation developed by SUNY, discovered a direct link to lower test performance as well as a decrease in decision-making ability and the capacity to think strategically.

The combined effect of these illnesses is an increase in absenteeism for students and staff as well as overall diminished academic performance—currently referred to as "Sick Building Syndrome."

The Unforeseen Green Effect

With the welcomed introduction of global green initiatives in construction and renovation, buildings have become increasingly air-tight and, therefore, more efficient—saving millions of dollars in energy bills and significantly lowering greenhouse gas emissions and our overall carbon footprint. However, this reduction of indoor to outdoor airflow has also inadvertently increased the accumulation of indoor pollutants. This issue is now being addressed with the implementation of new green certifications like WELL in addition to the already established building certifications of Leadership in Energy and Environmental Design (LEED).

The U.S. Green Buildings Council requires a minimum efficiency reporting value (MERV) score of 8 or above for building air filtration systems. MERV measures how effectively an air filter removes particles from the air moving through it—the higher the MERV number the higher or the finer the filtration. For LEED certification, as of May 2016, the MERV requirement is 13 or higher in mechanically ventilated buildings, according to the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standards.

Shining Examples

In 2014 Yale updated a historic building containing two of their chemistry labs. The original construction, done in 1923, was considered technologically advanced with a state-of-the-art natural ventilation system, but that was almost 100 years ago. Yale's ongoing commitment to sustainable building practices led them to pursue the LEED Gold certification which required a higher level of air filtration over an expanded amount of educational space along with an increase in natural lighting. With the installation of low static pressure air filters, which require far less energy to power and eliminate the need and cost of prefilters, Yale was able to recoup the investment in two years while also meeting their sustainability goals.

The Worchester Polytechnic Institute is home to one of the country's greenest sports centers with a MERV rating of 15—exceeding LEED's certification standards for air quality. The sports center is home to a pool, four-court gymnasium, dance studios, and an indoor track as well as meeting rooms and offices. This drive to promote sustainability has generated a campus-wide interest in energy-related student projects while fostering better environmental stewards for the future.

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ABOUT THE AUTHOR: Hilary Moreno is an alum of Birmingham-Southern College. Currently, she is the Creative Director and a staff writer for Flaherty Media.

At the northernmost point of the Yough, along a five-mile stretch of water and rocks and steep plateaus called Bear Run, Frank Lloyd Wright designed Fallingwater in 1935. He was hired by the Kaufmanns, a prominent Pittsburgh-based family that desired a remote vacationing spot in Pennsylvania. Upon its completion in 1938, Wright would land the cover of *Time*, posing with his illustration of Fallingwater. Nearly 70 years later, *Smithsonian* would include Fallingwater among its "Life's List of 28 places to visit before you die."

Key Lessons from Fallingwater

If you'd like to see your higher education facilities transformed into beautiful, safe, and innovative living and learning spaces, key lessons can be learned from Fallingwater, not only in terms of the aesthetic value in its naturalistic design but also in regard to the wide-ranging benefits (physiological, psychological, and economic, to name just a few) that such a design can produce.

Fallingwater is surrounded by the dense flora of the Appalachian Oak Forest, and its design echoes a natural pattern established by neighboring rock ledges. In this case, cantilevered concrete "trays" are stacked, together forming a mass sturdy enough to overlook the waterfall that rushes *beneath*—rather than above—the structure. It is a thrilling design, one that defies the laws of nature.

Wright's legacy is one of innovation, but he also had a sizeable ego. Fallingwater, however, is not simply a reflection of Wright's hubris, his ambition to conquer nature. Its conception is derived from his wish to create architectural harmony between human habitation and the natural world.

Wright called this harmony "organic architecture," and within it he sought to achieve a sensibility of space in which the site, the structure, and its furnishings all become part of unified, interrelated composition. The structure rises more than thirty feet above the falls, and yet its strong horizontal lines and low ceilings produce a safe, sheltering effect. The outdoor terraces, which are almost the same square footage as that of the indoor space, bring the natural environment into the house just as they also entice its inhabitants out.

Biophilic designers work to reproduce the harmonizing impact of nature, and they do so by creating interior spaces that are inspired by natural materials and patterns. With biophilic design, one can transform higher education facilities into safe, sustainable, and beautiful living and learning environments.

Biophilic Design and Organic Architecture

Biophilic design is an extension of the values inherent to Wright's "organic architecture"—particularly, that nature holds the key to our aesthetic, intellectual, cognitive, and even spiritual satisfaction. Biophilic designers work to reproduce the harmonizing impact of nature, and they do so by creating interior spaces that are inspired by natural materials and patterns. With biophilic design, one can transform higher education facilities into safe, sustainable, and beautiful living and learning environments.

An ideal biophilic space contains windows that overlook lush natural spaces, that likewise can be opened at ease to create desired ventilation and temperature. A direct view of nature also orients the occupant with day and season. Indoor plants can be used to encourage a direct relationship to nature and make possible a multisensory experience, one not only tactile but also olfactory and visual. Water features may also be used to similar effect.