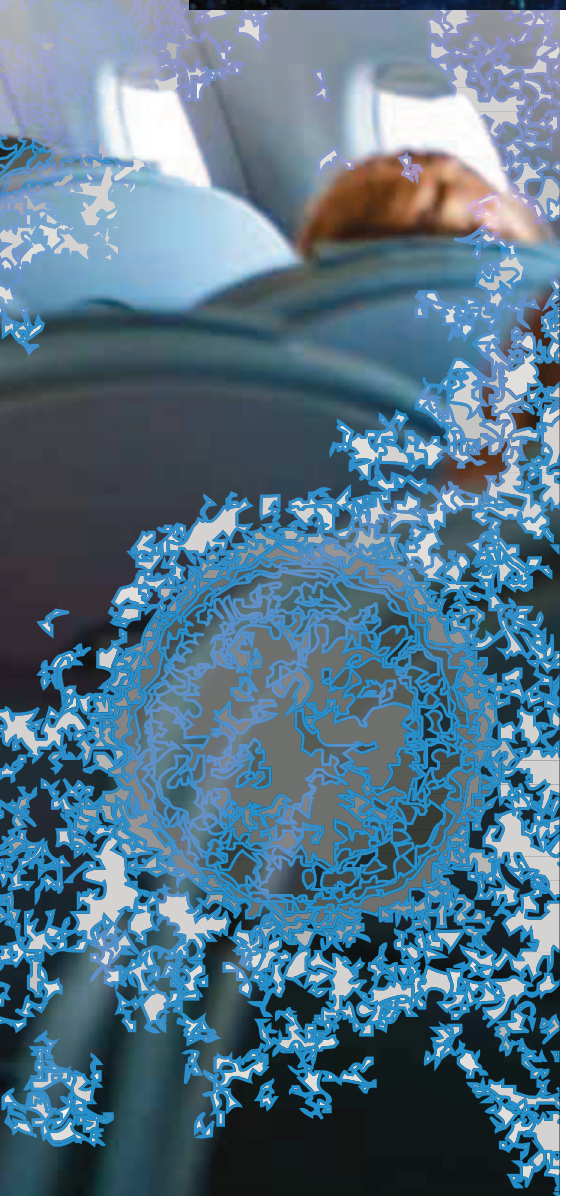
Doug Walkinshaw (PhD Mechanical ’70) has played an influential role in indoor air quality in Canada and around the world, earning professional accolades and a U of A Alumni Award.

The air that you breathe

Doug Walkinshaw has had a major impact on indoor air quality across Canada, and around the world

by Richard Cairney



Blair Gable

During an age in which fears of global pandemics run at a fever pitch, we're more aware than ever of our surroundings and public health threats. We wash our hands compulsively and shun our coughing co-workers. So at the peak of flu season, where would you rather be: on a packed bus or subway car for 30 minutes, or in an NHL arena watching your home team go into a thrilling triple overtime game? Remember—it isn't a question of which is more entertaining. You may enjoy people-watching on public transit more than the Edmonton Oilers' inevitable victory over the Calgary Flames. The question focuses on which environment you'd feel safer in, from a public health standpoint. So? Which would it be?

Few of us would choose the crowded subway car. All those bodies crammed into such close quarters? Ugh. If ever there were a probable epicenter for airborne disease transmission, this would be a hot zone. But Doug Walkinshaw (PhD Mechanical '70) would pay his fare and step aboard the subway without hesitation. "The arena is a bigger risk because the exposure time is potentially so much longer and therefore the number of viruses inhaled, on average, substantially higher-in fact, eight times higher," explains Walkinshaw, an internationally renowned expert in indoor air quality. He introduced the idea to ventilation engineers that the integral-of-exposure-with-time might be a much more important indicator of air quality than air-exchange-rate and instantaneous concentration. "Being exposed to an infectious aerosol from the exhaled breath of a sick person for a half-hour on a crowded subway car is a less dangerous setting than in a crowded hockey arena for five hours."

It's counterintuitive, but in an upcoming research paper Walkinshaw calculates that one sick person in a group of 40 can spread many more germs through the air over five hours than he or she can over 30 minutes in tighter quarters. Duration of exposure, ventilation rate per person, occupancy density and air currents are the key considerations, he says. "Of course if you are directly coughed on by an infected person in either setting, all bets are off."A summary of his calculations of

exposure risk for thirteen common settings, along with the exposure duration used, appears on page 17.

The irony of Walkinshaw's research is that he will be flying to present his findings at an international conference in Kuala Lumpur this November. And transcontinental flight is an even riskier proposition. When it comes to airborne pathogen exposures, jetliners make crammed subway cars and hockey arenas look pristine. "Ten to 15 hours on a long-haul jet with a person onboard with the flu, or worse still, TB, is the highest risk exposure investigated," says Walkinshaw.

When it comes to airborne pathogen exposures, jetliners make crammed subway cars and hockey arenas look pristine.

There are countermeasures you can take—but we'll get to that later.

Walkinshaw has decades of experience in his field. He led the establishment of the National Research Council's first indoor air quality research program in 1982, contributed to the development of Health Canada's first indoor air quality guidelines in 1987, and a year later acted as a scientific advisor to the World Health Organization in drafting sick building syndrome guidelines. He was selected by his international peers as President of the 5th International Conference on Indoor Air Quality and Climate held in Toronto in 1990 with over 500 technical presentations and papers. He was a co-founder of the International Society of Indoor Air Climate and the International Academy of Indoor Air Sciences, and elected a Fellow of the American Society of Heating, Refrigerating and Air-Conditioning Engineers.

Today, Walkinshaw is owner of three companies: Indoor Air Technologies Inc., ECHO Air Inc. and VEFT Aerospace Technology Inc. The first leads his investigations and his basement ventilation technology implementation. The other two spearhead development of his ventilation technologies for aircraft and related spin-offs. He has received numerous accolades and this fall will be presented with the U of A's Alumni Honour Award in recognition of his contributions to society.

These are remarkable achievements for an individual who never planned to enter the ventilation and air quality area. After earning his Bachelor's and Master's degrees in civil engineering and engineering mechanics and his PhD in mechanical engineering, Walkinshaw began work in structural dynamics and shock and blast physics while working for the Department of National Defence at Defence Research Establishment, Suffield. There, he conducted a structural safety analysis for the proposed Gentilly nuclear plant in Quebec that helped win its approval, and was involved in the blast hardening analysis of the Canadian DDH 280 Iroquois class destroyer series built between 1964 and 1972. In 1972 he joined Public Works Canada, where he directed its new technological research and development program for buildings, bridges and marine structures, coincidentally heading the government's building energy conservation research program during the 1979 energy crisis follow up. In 1982 he joined the National Research Council (NRC) to oversee its urea formaldehyde foam insulation (UFFI) research being conducted by three of its research divisions and began an indoor air quality research program in the Building Research Division. There, he uncovered some alarming practices that put people's health at risk in the name of conserving energy, and began to specialize in indoor air quality.

"Everyone started boarding up air intakes to ventilation systems on building roof tops and sealing house air leaks to save energy. You draw in fresh air and you have to heat it, cool it, humidify it—all that takes up energy—and the field of indoor air quality versus energy conservation was born and became an emerging public health issue "

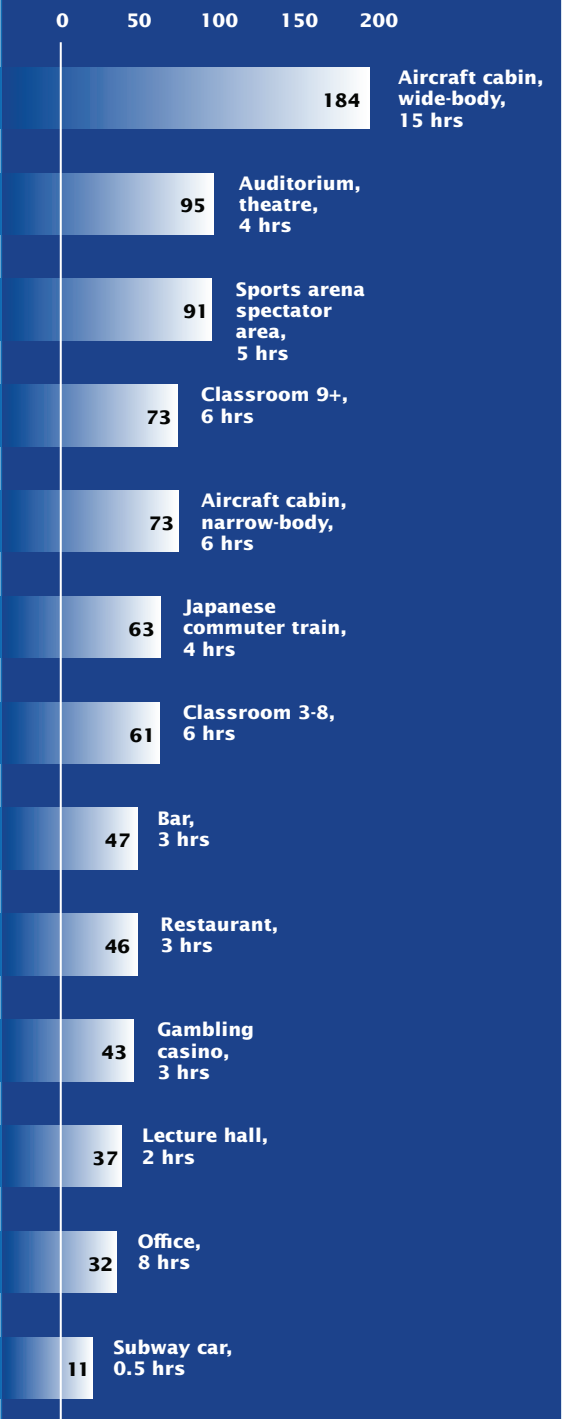
Nationally, the debate about the off gassing of formaldehyde from UFFI raged on while Walkinshaw began learning everything he could from colleagues in the NRC's Fire Research Centre—particularly how to measure trace quantities of volatile organic compounds (VOCs). Walkinshaw and his fire research colleagues discovered that photocopiers at the NRC Canada Institute for Scientific and Technical Information library were a major source of VOCs. These machines were spraying a petroleum-based toner dispersant which wet the entire page in order to apply the print and the paper was then heated to dry it, putting a characteristic fingerprint of n-nonane, n-decane and n-undecane and other VOCs into the air. Over the course of a year more than 100 gallons of these isoparaffinic hydrocarbons were emitted into the air of the library to be breathed by occupants and taken home on clothes and hair. It turned out that this same photocopier type was widely used in Canadian schools and government offices. Its manufacture and use has since been discontinued.

Walkinshaw has conducted over 300 investigations in buildings, homes and aircraft. His most extensive investigation was of the McDonald-Cartier Building in Kingston. This building houses the Government of Ontario employees who process Ontario's Medicare payments and produce its wallet-sized plastic driver's licenses. It opened in 1979 and soon after, workers began to complain they were getting sick. Between 1988 and 2002, before his investigation, there were seven different studies made of the building air and three studies of coal tar migration near the building raising the concern that toxic tar fumes were entering through the foundation. Walkinshaw conducted a three-year investigation into the building's air quality beginning in December 2002, uncovering multiple air quality problems and hazards leading to an $11-million renovation.

Although there were suspicions that the site's landfill materials and its proximity to a former coal gasification plant with coal tar found oozing through the fissures in the limestone nearby, "the main chemical in the

Influenza Viruses Inhaled

Number of influenza viruses inhaled during at rest, awake, tidal breathing in the 13 environments by groups exposed to the exhaled breath (coughing not incuded) of one infected person based upon design (maximum) exposure time, fresh air ventilation, filtration and occupancy denisty differences.



Source: Walkinshaw, D. "Germs, ventilation, occupancy density and exposure duration, a thirteen setting pathogen inhalation comparison", American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) conference proceedings IAQ 2010.

air of that building was from photocopiers and the main problem was from respirable dust tracked in on footwear and deposited under desks on the wall-to-wall carpet and aerosolized by vacuuming and foot movement," he says. "And that is typical of many office buildings. Photocopiers should be located in special rooms that are air sealed and exhausted directly to the outdoors. There really should not be carpet in office buildings but if there is, the desk chair and occupant's feet should rest on a plastic pad over the carpet."

Walkinshaw also conducted groundbreaking environmental tobacco smoke research at three prisons, which ultimately led to a ban on smoking in all Ontario prisons—a first in the country. The move was heralded as a major public health victory for both guards and inmates: today, smoking is not allowed in any provincial or federal prison.

Another study, in a public school, found significant sorption by the children of 1,4 dichlorobenzene, a leukemogen whose source was the disinfectant and odorant used in washrooms.

On the residential front, Walkinshaw has developed technology to solve basement cold and dampness problems and prevent soil gas entry. His ECHO System technology uses an energy efficient continuous-duty blower to depressurize and vent air from behind specially constructed tightly sealed walls and a thin, low-emissivity subfloor to the outdoors. A similar envelope pressurization system has been developed for aircraft, where cabin humidity will condense and freeze behind the wall liner on the cold fuselage during flight and then melt on the ground, creating dead weight, microbial growth, reduced insulation performance, metal corrosion and electrical failures.

Back to that transcontinental flight to Kuala Lumpur: Air quality on airplanes is a serious public health issue that Walkinshaw is working on. Studies have shown that the common radius of airborne spread of infectious agents is at least six rows in either direction of an infected person. However, aisle seats and seats near lavatories are more prone to air currents generated by people moving in the aisles and, therefore, more likely to be exposed to airborne pathogens from an infected person. Today, Walkinshaw is working with a Boeing colleague to design safer 'gasper' overhead climate control nozzles for aircraft passengers. This technology is currently in the early patent protection stage, but according to his Boeing colleague promises to eventually guide the direction of future design. Currently, the air from these gaspers draws ambient air into their flow, increasing the chances of the spread of pathogens from neighbours when pointed at the face. The design Walkinshaw and his Boeing colleague have developed would still draw that ambient air—but it would be filtered first before leaving the nozzle.

"The air flow from the new nozzle would be more like that from a large shower head than from a jet," he explains, adding that there are measures you can take personally in the interim to reduce the risk of airborne infections while onboard an airplane. Walkinshaw advises people to choose window seats over aisle seats and try not to sit near the washroom. And as for that overhead air nozzle? Never point it directly at your face, he warns—but do use it to create a protective curtain between you and your neighbour, coincidentally entraining and drawing any germs to the floor of the cabin where they will be exhausted to the outdoors or filtered before the air is recirculated.

"If your plane has overhead personal air outlets, turn on the outlet and direct it between you and of the neighbor you are most concerned about from a potential infection viewpoint, pointing it between the two of you toward the floor."

Whether it's practical tips like these or planning and carrying out investigations that span years, Walkinshaw has had a tremendous impact on public health. But he hasn't really stopped to consider that—he's too busy working towards new solutions to pause and reflect on it.

"I don't have any idea of what impact I have had," he says. "I'm still working. There's still a long way to go—I'm not sitting back." With several patents pending and under development and clients waiting for his indoor air quality investigations and solutions, he certainly is not.