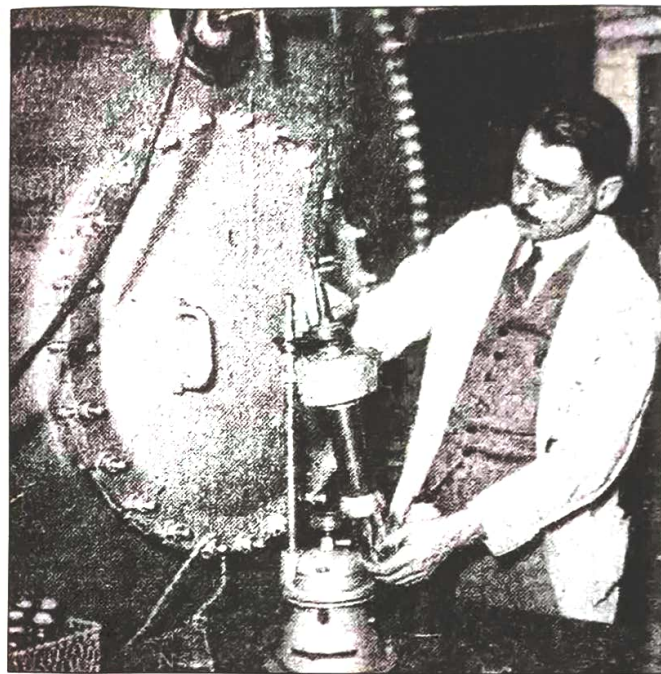


Do buildings need immune systems?

Carl Zimmer writes about a US agency that is spending big money on technology to keep indoor air safe in crèches, schools, hospitals



PIONEERS: Mildred and William Wells famously protected children in Philadelphia schools from a measles epidemic in 1940 by installing ultraviolet lamps that disinfected classroom air. "I believe that a provision of pure air for children (and adults) to breathe should be looked upon as of equal importance to the provision of pure water and pure milk," Mildred Wells later wrote. But she and her husband failed to sway their colleagues, and the threat of airborne germs went underappreciated for generations

Linsey Marr, an environmental engineer, stood next to a pair of clear plastic boxes packed with tubes, nozzles and electronics, an odd-looking prototype that one day might serve to protect children in daycare from airborne viruses.

A nozzle filled the right-hand box with a faint silvery mist. A pump pulled some of that air into the left-hand box, where a sampler trapped floating particles and droplets. Soon, a digital screen bolted to the box turned red: "Detected! Dust mite allergen Der f 1."

A protein shed by dust mites, Der f 1 can trigger asthma attacks when inhaled. Marr's device had detected 843 picograms of Der f 1 per cubic metre. A single grain of salt is about 10 million times as heavy.

Dust mite allergens are not the only threats that Marr's team aims to fish from the air. The technology, still evolving, can already sniff out influenza, coronavirus and *E. coli*.

"We have 10 different things that we're able to detect, and by the end of the programme, there will be 25 different things," she said.

Marr was shouting over the din on the fifth floor of a Washington office building where more than 200 people milled about, getting a first look at a rapidly evolving frontier in science — technology designed to keep indoor air safe in daycare centres, schools and hospitals. This grown-up science fair was hosted by the Advanced Research Projects Agency for Health — ARPA-H, for short — which is spending \$150 million to create what it calls "an immune system for every building".

At the start of the event, programme manager Jessica Green gave a brief welcome speech. "We have the right to be breathing healthy indoor air," she said.

Green was echoing the words of William and Mildred Wells, a husband-and-wife team that discovered the threat of airborne germs in the 1930s. But the Wells failed to sway their colleagues, and the threat of airborne germs went underappreciated for generations. When Covid-19 hit in 2020, the World Health Organization emphatically stated it was not airborne — which turned out to be wrong.

Marr, who teaches at Virginia Tech, US, played a leading role in getting public health authorities to recognise that the coronavirus was in fact airborne. She and other researchers were frustrated by how hard it could be to identify such viruses.

"We'd spend a day collecting samples onto a filter, we would take it to the lab and the next day it would take us several hours to figure how much is in there," Marr said. "And by the time you have that number, it's too late to do anything about it."

Covid never left; it only joined a growing cadre of airborne viruses.

Measles, which is entirely airborne, is having a resurgence in undervaccinated pockets of the US. Influenza spreads by several routes, but air appears to be an important one. Beyond infectious germs, indoor air can also harbour other

threats, such as dust mite proteins, mould spores and pollen grains.

Engineers have continued to develop sophisticated systems to keep air healthy. High-end apartment buildings occasionally boast about the technology used to keep tenants safe. But these systems are far from ubiquitous.

"One of the reasons healthy indoor air solutions have yet to scale in the marketplace is because they're expensive," Green said in an interview. "What we need are solutions that can

Beyond infectious germs, indoor air can also harbour threats such as dust mite proteins, mould spores and pollen grains

be both energy-efficient and healthy." Green, herself an expert on airborne microbes, started the programme at ARPA-H to work toward those solutions. The goal is to have buildings fight disease the way they fight fires.

When smoke triggers smoke detectors, a building's control system can respond, spraying water from sprinklers or releasing fire-suppressing chemicals. It doesn't have to wait for someone to inspect the signals and decide how to respond.

It's a lot harder to identify viruses than to detect smoke. A very low concentration of germs or allergens means sensors have to sample huge volumes of air, storing droplets and particles in liquid to analyse them.

Four teams won contracts to create these systems. Each team is trying a different strategy.

SafeTraces, a California company, leads a group building an air sampler that's a wide, low, white metal box.

Air flows through the box into a cartridge, where chemicals break down cells and isolate genes they contain. The cartridge contains molecular hooks, each of which can snag a specific sequence of DNA or RNA from a virus. If a hook catches any genetic material, it gives off a flash of light.

The researchers are also building software that can recognise when occupants are at high risk of getting infected.

The software might then respond, perhaps by turning on ultraviolet lamps in a hospital's ventilation system. (UV light kills many airborne hazards.) Hospital personnel might get messages to use extra protection so that they wouldn't inhale the viruses. And once the sensors detect that the threat is gone, the hospital could return to business as usual.

Another team, led by the Florida company Poppy, is designing a system that would work in schools. Signals from the team's air samplers would switch on air filters in classrooms. They would run until the air in the classrooms was safe again.

Marr's group has focused on daycare centres. The team is creating software that can make models of the rooms in a centre, predicting how air flows between them and the threat each room would pose if someone entered the building with an infection. The system could pump fresh air from the outside or switch on air purifiers to reduce the threat.

All the teams are working towards putting their systems to the test in the real world.

NEW YORK TIMES NEWS SERVICE