The Statewide Committee for Research honors Alaska's

Northern Innovators

Cathy Cahill

The Air Sampler

Northern Innovators Hall of Fame Member

On a cool spring morning in the mountains of southwest Washington, 12-year old Cathy Cahill, on a family road trip from home in California, helped her dad set scientific instruments around the base of trembling Mount St. Helens. A few days later, the volcano blew up, smothering two of his four ash collectors. When he gathered the survivors, Cathy's father found a downwind sampler overflowing with ash laced with chlorine. Tom Cahill of the University of California, Davis, wrote a paper on this surprising result.

Tom's teenage daughter was not a co-author on her dad's Mt. St. Helens paper, but since then her name has appeared next to his in a few journals. Driven by the opportunities and problems that emerge in a land often cloaked in wildfire smoke or hazy with volcanic ash, Cathy, 44, continues to stamp her own impression on the field of atmospheric science.

The University of Alaska Fairbanks professor has captured and examined the particulates floating in the air breathed by U.S. servicemen and women in far-off deserts and in the air above urban battlefields. She has gathered air samples from Afghanistan to the Aleutian island of Adak. She has invented an air-sensing system that alerts pilots they are encountering volcanic ash particles. She has become a sought-after expert regarding the bitter, smoky midwinter air of her adopted home of Fairbanks and serves as a fellow to the U.S. Senate Energy and Natural Resources Committee.

To better sniff the air around volcanoes and inside fire plumes, she also commands a fleet of 161 unmanned aerial vehicles. Cahill will also enlist the drones to expand her ground-based studies of air from Iraq, Djibouti, Kuwait and other regions in which Americans are fighting.

"The military has a healthy population, but we're still seeing increases in respiratory diseases in soldiers that are coming home," she says in her office that overlooks the flats of the Tanana River valley, which hosts both an Army post and an Air Force base. "They call it 'the Iraq crud' — you come back hacking. We're trying to find out what might be responsible for some of these respiratory ailments."

Along with the health of men and women, military officials have also asked Cahill what particulates are doing to their machines.

"A lot of soils behave like volcanic ash," Cahill says. "That's part of the reason engines tend to get destroyed in Saudi Arabia. The soils there can melt in the engines. And soils in high enough concentrations also abrade. If you have high concentrations and you fly through them again and again, you're going to wear out your aircraft."

Volcanic ash, often wafting in the atmosphere over Alaska, consists of tiny rock shards and glass that can sandblast aircraft windows, paint and internal parts. If an engine sucks them in, melted ash coats the interior of the engine and blocks cooling vents on turbine engine blades, causing the engines to shut down.

Cahill's brain locked on that problem and wouldn't let it go. Before long, she filed a patent for on onboard sampling system that sounds an alarm if pilots are flying into particulates that have the characteristics of volcanic ash.

For years, Cahill has used traditional ground-based samplers that consist of tiny rotating drums that hold sticky, particle-catching films. That fashion of collector has helped scientists conclude that Denali has the cleanest air of any national park and that soldiers in Baghdad were breathing in ghastly amounts of dust and smoke.

Cahill has now taken her measurements to the air. She has acquired 160 AeroVironment Ravens (which have a wingspan, at 55-inches, more like that of a sandhill crane) and one Boeing Insitu ScanEagle (which weighs 10 times more and has the 10-foot spread of a California condor).

"There's a bunch of things you can't do at ground level. If you're looking to measure a volcanic plume downwind, usually it's elevated, and you can't get into it. It's very hard to get in and out of wildfires. And there are a lot of measurements where vertical distributions would be very important.

"You can follow a plume downwind and cross it back and forth, try to hit the same part of the plume each time," she says. "The goal is to be able to get measurements to validate satellites and models without putting people at risk."

Before Cahill does any of these things with unmanned flying machines, her air-sampling equipment needed to shrink enough that a drone could carry them. With the help of university machinist Greg Shipman and electronics specialist David Giesel of the unmanned aircraft program, she moved her samplers from a 40-pound Pelican case to an eight-pound unit that fits in the nose of an unmanned aircraft.

Going airborne is just another step in the life of the little girl who followed her father's footsteps over a volcano many years ago.

"My entire career's thread is aerosols — the sources, atmospheric transformations, transport and impacts. If you're studying the atmosphere, you want to be able to go up in it."