PHOTO BY LINDA KASTLEMAN

The birth of BioDeptronix—

Scientific improvisation puts researchers in good company

Will Vizuete is a huge fan of jazz. In 2009 and 2010, he was disc jockey for a weekly jazz program on WXYC, the UNC campus station, and he's still a volunteer DJ on occasion. Part of what he loves about jazz is the improvisation, the innovation. A musician may start with a riff and suddenly take it in a completely different direction. Another responds, works off the new riff on the fly, then improvises. Around the ensemble it goes, on beat, off beat, an impressive, dynamic, never predictable journey.

In some ways, jazz is similar to Vizuete's work as a scientist.

This is especially so in the last few years, during which Vizuete joined an ensemble of colleagues and became entrepreneur and co-founder of his own start-up company – a venture that came out of the not-so-thin air. In fact, it was the gritty, smoggy air.

Early in his career, Vizuete knew smog and other air pollutants caused asthma, lung cancer and other respiratory illnesses. But was the illness related only to the number of pollution particles, he wondered, or were there times of day or particular locations that made people more vulnerable to respiratory problems?

"[Based on the EPA's models], toxicity is determined by how many toxic particles are in the air," Vizuete says. "But if you examine data showing how many people die from lung ailments per cubic meter, you see that more people die in one area of the country than in another, even when the particulate mass per volume is identical. That means an important factor is being missed in the calculations."

That factor, Vizuete believed, was right overhead – the sun.

"You can take an air sample and expose it to a day's worth of sunlight," he explains. "The sun sparks chemical activity, and the

molecules absorb radiation. By sunset, the toxicity of that same sample has increased by five to 10 times its original levels."

Vizuete knew this because, as a graduate student at The University of Texas at Austin, he had a chance to conduct research with Harvey Jeffries, PhD, professor emeritus of environmental sciences and engineering at the Gillings School of Global Public Health.

Jeffries built the smog chamber that sits atop the School's McGavran-Greenberg Hall, the first of its kind. The opportunity to work with Jeffries and see first-hand the data garnered by smog chamber sampling did much to inspire Vizuete's interest in atmospheric chemistry.

The smog chamber revolutionized analysis of exhaust pollution and allowed researchers to replicate conditions in virtually any locale in the world. It had limitations, however. It was immobile and expensive to build, and shifts in the wind or quickly changing weather situations could render data useless. Vizuete was even more troubled by the analysis that happened after the sampling was done.

"We know that the smaller the particles, the more deadly they are," he says. "This is especially so when they get below 2.5 micrometers in diameter. But around the world, air sample analyses use a liquid suspension. When the particles are suspended, they agglomerate and form bigger particles. We weren't analyzing the riskiest pollutants. I kept thinking, 'We need a better way to do this.'"

Jeffries and Dr. David Leith, retired professor of environmental sciences and engineering at UNC, had the same thought back in 2002. They tried to repurpose a piece of equipment from the mid-1970s, an electrostatic precipitator, to perform smog analysis that didn't require the liquid suspension. By the time Vizuete met them, Jeffries and Leith had adapted the precipitator, placing the refrigerator-sized unit into an incubator and connecting it via a long, sealed duct from the smog chamber on the roof down to the basement of Rosenau Hall.

The reconfigured precipitator allowed researchers not only to examine samples directly, but also to see the effects when the samples were exposed to cultured lung cells and other tissue.

"But what if we could take the whole thing to Houston, Los Angeles, London, Beijing or wherever?" Vizuete asked. "What if we could set it up in a neighborhood adjacent to a factory or a refinery that was emitting high amounts of pollutants? Or bring it inside a building where some air-based environmental hazard was suspected and do sampling right there, in real time? Our data would be so much better, and we could better establish the risks of being in these cities or near these facilities. We could institute preventive measures."

Idea, meet improvisation.

PHOTO BY LINDA KASTEMAN

Dr. Ken Sexton (left) and Dr. Will Vizuete describe the operation of the smog chamber on top of McGavran-Greenberg Hall.

Vizuete joined the UNC environmental sciences and engineering faculty in 2005 and soon began discussing his idea with Kenneth Sexton, PhD, now a retired research professor from the Gillings School.

By 2007, they decided to see whether they could build a portable electrostatic unit. But where should they start in creating a sophisticated scientific device from scratch?

Why, with Glenn Walters, of course.

Walters is director of the Environmental Sciences and Engineering Design Center, a one-stop fabrication shop. He and his colleagues and students create devices of all sorts, made of metal, plastic and other materials, for researchers at the Gillings School of Global Public Health and across campus (See page 10).

"My primary area of study is wastewater, and I had no direct experience in electrostatics or lung tissue sample analysis," Walters says. "But my current portfolio is 'whatever comes along.' This often means I spend a lot of time discussing with researchers not only what they want but also the science behind it."

One of the mechanical challenges was to enclose an incubator within the unit rather than the other way around. The sampling process, which involved a series of collection areas, also had to be refined. Each area was dime-sized and included a semipermeable membrane. The thought was to make it larger so as to increase the sensitivity of the readings.

"It's always a puzzle when you start a new project, even one that has some established principles and components involved," Walters says. "It's almost like saying, 'Let's write a book.' There are lots of ways to approach a problem. There are times when you get two or three months into a design and start wondering if you need to scrap or just recast it."

The three men persisted, obtaining a Gillings Innovation grant in 2008 to help support their efforts. It took "eight or nine iterations," but by 2009, they had a fully functional prototype with a self-contained incubator and the capability for more sensitivity than the repurposed electrostatic precipitator would have allowed. The device was now the size of a large suitcase. They called it "The Gillings Device," and its completion mandated the next improvisation: entrepreneurism.

"This was something completely new for me," Vizuete says. "I'd never started a company."

He decided to take a new UNC class for entrepreneurial-minded faculty and staff members and students called "Launching the Venture." There he met Dr. Don Rose, director of Carolina Kick-Start, a program designed to help support UNC faculty members in their entrepreneurial efforts.

"[Vizuete and team] ended up being the first venture we formally supported, and they've quickly become a poster child for the program," Rose says. "They had a great product. We helped them take the steps toward becoming a viable venture, from assisting them with patents, corporate structure and other legal issues to pairing them with a great chief executive officer, Chris Price."

The fledgling company, named BioDeptronix, garnered nearly $250,000 in support, including $150,000 from the National Institutes of Health and $50,000 from the National Science Foundation. The U.S. Environmental Protection Agency has registered strong interest in purchasing the first commercial rendition of the product.

"I'm very happy and grateful that there are people like Dennis Gillings and Joan Gillings who contribute to programs such as the Gillings Innovation Labs, which can support development and translation of science to beneficial products," Sexton says. "I'm also grateful that the School and UNC are supportive of such funding programs."

Rose sees the process as a natural outgrowth of research predicated upon direct response to a pressing societal need.

"This is a great example of researchers looking to solve a problem – which is what public health is all about – and then making that solution available for wider use," Rose says. "[BioDeptronix's] solution is effective. It's cheaper, it's portable, and it's 10 to 100 times more sensitive than what is available now. This is a product that could develop over time and provide many people with better data. That leads, in turn, to better solutions for some pressing public health issues."

From an idea to collaboration to focused effort, with a bit of improvising along the

Glenn Walters–

Tinkering his way to an innovative academic career

Dr. Glenn Walters is at home in the ESE Design Center.

PHOTO BY LINDA KASTLEMAN

As with many budding researchers, Glenn Walters found his calling in the field. In his case, however, "the field" was not a clinical site, a remote corner of the globe or a neighborhood ruined by industrialization. For Walters, inspiration came from a junkyard.

"The junkyard wasn't far from where I grew up in Vermont," Walters says, "and I was always over there looking for old TVs, car parts and things like that. I was always taking things apart, but it drove my father nuts that I did not always get them put back together correctly."

When he was in high school, Walters befriended a local contractor who had a metal-scrapping business. One of the man's clients was IBM, which had a research and development plant in nearby Essex Junction.

"I would get switches, conductivity meters, process controllers, scrap wire and switches from him. Anything I could get my hands on. I even got hold of a chip fabricator once," Walters says, with more excitement than you'd expect a chip fabricator to generate. "I used to break parts down, hook other parts up and try to figure out how everything worked."

Walters didn't have the same level of interest for his school work, however.

"I wasn't a very attentive student. In fact, I barely graduated from high school," Walters says. "I had no intention of going to college."

way, Vizuete's career took a turn he hadn't anticipated.

"I never thought in terms of starting a business or creating a deliverable product," he says. "But now we're already thinking about other uses for the device that could include partnering with other companies. We might want to increase the device's sensitivity to account for nanomaterials or develop real-time personal samplers that could be used in homes or businesses. There are a lot of directions we can go from here."

Sexton agrees.

"This instrument ultimately can be deployed and used in homes, as well as other buildings and workplaces."

In some ways, it's a lot like a good jazz riff. So many new ideas are just waiting to waft off the original one. All it takes is talented players, hard work and a good sense of improvisation when the right moments come along.

—David Pesci

RESEARCHERS FEATURED IN THIS ARTICLE:

Harvey Jeffries, PhD, is professor emeritus of environmental sciences and engineering (ESE) at the Gillings School.

David Leith, PhD, is a retired ESE research professor.

Don Rose, PhD, director of Carolina KickStart (*tinyurl.com/NCtracs-Carolina-Kickstart*), received his bachelor's degree in nutrition from the Gillings School.

Kenneth Sexton, PhD, is a retired research professor of ESE.

Will Vizuete, PhD, is associate professor of ESE.

Glenn Walters, PhD, is director of the ESE Design Center and an ESE research associate.

However, after a year of working odd jobs, including pumping gas during one of the coldest winters on record in Vermont, Walters saw only one way to get ahead–college.

"So I enrolled at a local junior college in the business management program, and it all just clicked," he says. "I was highly motivated, worked hard and quickly became ranked at the top of my class."

After graduation, Walters was hired as membership manager for the Vermont Chamber of Commerce. It was a great job for a young person, traveling around the state, meeting with businesspeople. Still, he wanted to do something more substantive. A battery of aptitude tests and talks with a career counselor pointed toward engineering.

Walters subsequently enrolled at the University of Vermont, earned a Bachelor of Science degree in civil engineering, with an emphasis on environmental systems. He worked for a time at an environmental consulting firm in Alaska, consulted with a Boston-area firm for several years, and then started looking at graduate schools. The search led him to UNC, where he earned his doctorate in environmental sciences and engineering at the Gillings School of Global Public Health.

He also found his way to the ESE Design Center in the basement of Rosenau Hall, where the facility's then-administrator, Randall Goodman, recognized Walters as both an experienced engineer and skilled craftsman. Before Goodman retired in 2007, he recommended that Walters be brought on as the new director. Because of Walters' advanced degree and training, the position was enhanced to include an academic component, as well.

Walters quickly expanded the operation, developing a more capable facility that could provide services University-wide.

"We do everything from basic design and simple repairs to some very sophisticated work with metals, plastics and other composite materials," Walters says. "We'll take on almost anything."

Along with the Gillings Device (See page 8) and a wide array of other projects for ESE researchers, this "anything" has included membrane filtration cells for RTI International (*www.rti.org*), special testing chambers for a UNC School of Dentistry pain-control study; an inhalation toxicology for UNC's School of Medicine; and an estuary-sampling instrument for the Department of Marine Sciences.

"We've also been working on a highly sensitive swallowing monitor for premature infants that helps new mothers differentiate various sounds the infants make while feeding," he says.

Crafting these devices requires more than making them functional. Many have to be shrunk down, simplified, expanded or even made to look like something they are not.

"Often they have to be made to look as if they have no apparent value," he says. "Many of the researchers with whom we work travel to parts of the world in which sophisticated-looking things have a way of disappearing."

It's a long way from collecting scrap electronics, but Walters wouldn't have it any other way.

"A lot of what I learned back then informs what I do now," he says with a smile. "I may not have taken the typical path to an academic career, but I love where I am. Every day presents a new challenge, a new thing to build or take apart and put back together in a different way."

—David Pesci

The ESE Design Center serves more than 60 clients at the School, across campus and at other organizations, each year responding to more than 100 work orders of varying complexity.