

FACES OF
MASS SPECTROMETRY

Jack Cahill



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July 2025



Tackling Challenges with Enthusiasm

When it comes to science, Jack Cahill is not afraid of a challenge. In fact, it was Jack's experience with a rigorous high school chemistry class that first captured his attention and sparked his interest in scientific pursuits. As a R&D Staff Scientist at the Oak Ridge National Laboratory (ORNL), Jack engages with challenging questions about complex biological systems on an everyday basis, which is one of his favorite parts of the job.

Jack was introduced to mass spectrometry as an undergraduate student while completing a National Science Foundation (NSF) internship at North Carolina State University. He went on to obtain his PhD from the University of California, San Diego. While there, Jack studied atmospheric chemistry using mass spectrometry. He also gained experience using mass spectrometry to study single cell chemistry, which was an area he was keen to explore further after earning his degree. Jack accepted a position at ORNL, which was an excellent match that aligned with these interests. At ORNL, one of Jack's current areas of focus is developing methods and techniques to better understand complex biological systems

such as soils, plant systems, and processes associated with chemicals that occur below ground.

Jack believes the ability to devise creative solutions when faced with difficult problems is among the most important qualities to achieve success as a research scientist. He is a two-time recipient of the R&D 100 Award, which recognizes the development of innovative technologies. Reflecting on these achievements, Jack says they are important to him because they demonstrate that these technologies and methods can have a broad impact on the general community.

Since your family does not have a scientific background, how did your interest in mass spec begin?

My interest in mass spec did not start until late into my undergraduate years. I was doing an NSF internship at NC State University, and out of sheer luck, I was paired with a mass spec group. That was my first interaction with mass spectrometry, and that is what started the train rolling.

Did your time growing up on a farm influence your eventual decision to pursue a career in mass spec?

Just to clarify, I did not actually work on a farm. I grew up in the "farm town" of Franklin Grove, IL, which had about 800 people or so, and was in the middle of cornfields. When you have a town that small, you do a little bit of everything. In the summers, I would do work on different chores and things like that. But in my youth, I did not have any introduction to mass spec. My interest in science, specifically in chemistry, started in high school. My high school class was very small, with about 30 people total. I remember my high school chemistry teacher had a hard class, which was kind of unusual. I really enjoyed the challenge that he created—it stuck with me and piqued my interest. Later, I discovered that mass spec is a great tool for probing chemistry. So, it was a natural extension from there.

How did your years in grad school at the University of California San Diego, influence your interest in mass spec?

For grad school, I applied to a bunch of various places. When I visited UCSD, I was grouped into the analytical section; from the mass spec work I did at NC State. From there, I started talking with some of the professors, and I ended up working with Professor Kimberly Prather. She described what she was doing in atmospheric chemistry and how she used mass spectrometry to get at the chemistry of single particles. I thought that was really fascinating. I enjoyed the atmospheric chemistry side of things and wanted to do more field work in that area. It just really checked all the boxes.



“Creativity plays the most important role out of all aspects of being a research scientist—if you’re not creating or coming up with unique ideas to solve problems, you’re not going to advance very well.”

Jack at the top of Angels Landing at Zion National Park. (Photo courtesy of Jack Cahill)

How did you come to your current position at Oak Ridge National Laboratory (ORNL)?

During grad school, many of our mass specs were custom made. After grad school, I really wanted more experience with the typical mass spectrometry systems from bigger vendors, because I was looking for an analytical focus. Toward the end of grad school, I was adapting our single particle mass spec approach for measuring single cell chemistry, which was a very different analytical trajectory, and I wanted to explore it further. While I was looking around at the relevant literature, I found Gary Van Berkel, who was at the national lab. I contacted him and found the position, which ended up being a perfect fit!

What sorts of problems do you hope your work might help to solve?

In terms of biological systems, there are a couple of different aspects. We are doing a lot of work right now looking at below-ground root exudation. Part of my hope is to better understand the chemical dynamics that are occurring between plant roots and microbes through working with soils. We also are trying to understand heterogeneity in these biological systems through single cell metabolomics. Biological systems are, in general, very crazy and highly variable. Getting to real answers—or finding the real phenomena that are driving different interactions—can be difficult. A lot of my work is designed to create methods and techniques to answer some of these challenging questions.

We understand you are a recipient of the R&D 100 Award. What did this honor entail?

To be eligible for this award, you must have a patent or invention disclosure. You submit that to the R&D 100 team, and they determine which submission has the most innovative technology developed in that particular year. In my case, the award was for two different technologies: One for single cell mass spec, and then

one for *in situ* chemical imaging by mass spec for below ground systems. The significance for me is knowing the technologies we are creating are having an influence beyond our laboratory. I want to create technologies and methods that are applicable to the general community. Ultimately, we would like to see these technologies become commercial products that can have a larger impact

How has your involvement as an ASMS member helped you to grow as a scientist?

I first got involved in ASMS in 2014, which was when I started at ORNL. The community there has been instrumental in helping me to understand the breadth of mass spectrometry that is out there. My prior experience was limited to the atmospheric chemistry world. Through ASMS, it was amazing to see everything that’s possible in the broader mass spec realm.

What do you enjoy most about working at a national laboratory?

One thing I enjoy is that the problems we deal with are major problems—they go beyond what a single lab can do. That kind of challenge is both interesting and fascinating. A major aspect of this is collaborating with large teams of people, along with our individual experts, in a variety of different fields. In essence, I get to learn about all sorts of different disciplines all the time. Also, national labs have the capacity to do almost anything you want to do. Having access to those capabilities in one place is really advantageous for a research career.

How does creativity play a role in your approach to being a scientist?

It is absolutely essential. Creativity plays the most important role out of all aspects of being a research scientist—if you’re not creating or coming up with unique ideas to solve problems, you’re



“It’s very rewarding to see my students’ progression from working on something I’ve developed for them to independently working on their own intellectual property.”

Jack and his son, Aidan, set up for a hike at Rhone Mountain State Park. (Photo courtesy of Jack Cahill.)

not going to advance very well. Creativity is central to everything I do, and it ties into general interests throughout my life. In college, I was going to be an art major, and then a chemistry major. I transitioned from art to philosophy as my creative outlet. I then developed an interest in the research, which is essentially about coming up with innovative solutions to problems. As research scientists, we are often faced with challenges that cannot be addressed using existing technologies. Therefore, it is all about asking ourselves: How can we do this? How is it possible? From there, we use creativity to make it happen, and that is what I find very interesting.

What is a research topic you are currently focused on?

One of the research topics I am focused on right now is understanding the dynamics of chemicals that occur below ground—looking at things like soils. It is all about comprehending the spatial distribution of those chemicals. One of the challenges, of course, is that soil is really dirty. So, it is hard to see anything in it, and it gets hugely complex. In fact, it is probably one of the most complex systems on Earth! Still, it is vital to understand those processes in order to understand how a plant system, or another system, might impact our global nutrient cycle, global energy, and overall climate.



A collection of woodworking projects, a big hobby of Jack's. From top: a bookcase, a wine bottle box, trivets, and a barn quilt sign. (Photo courtesy of Jack Cahill.)



Tell us about your hiking and woodworking interests when you are outside the lab.

Growing up, my family used to go on big camping trips throughout the country. So, camping and hiking have been a part of my life since the beginning. Now, I am excited to be able to share that interest with my son, Aidan, who recently turned a year old, being out in the wild is always a lot of fun (Figures 1 and 2)! Woodworking is a hobby that has stuck with me because I really enjoy the creative process of how things are going to fit together with different shapes and sizes (Figure 3). It is just neat to be able to come up with unique designs. But that's kind of been on pause a bit more recently, depending on how the little one is doing!

What is your advice to others who don't come from a science background, but who are interested in pursuing a science career?

If you grow up in a small town, like I did, it can be hard to judge how intelligent you are, relative to the rest of the community. If I have learned anything, it is that intelligence, in terms of things like research science, is really just one component. There are so many other important pieces, such as being creative, having a questioning attitude, and being able to tackle these big challenges with enthusiasm. My biggest piece of advice is to embrace your curiosity. Don't let your history or background limit you in what you think you can do. Don't restrict yourself—just go for it!