

The Role of Undergraduates in Research: An Interview with Professor Sullivan



"It's spectacular; science is one of those things that spans all cultures and societies. Just as all cultures listen to and play music, all cultures engage in experimentation and science."

With his optimistic, high-level vision of science and research, Professor Neal Sullivan has successfully led the Colorado Fuel Cell Center (CFCC) for over a decade. From high-profile publications in *Science* on the characterization of SOFC efficiency to the development groundbreaking electricity storage technologies, the CFCC prevails as one of the premiere research laboratories on campus and in the nation. And, even with all of that success, Sullivan still spends much of his time considering how best to get undergraduates involved with scientific research.

According to Dr. Sullivan, it is vitally important for young engineers to get involved in research during their undergraduate careers because it teaches them how to think in terms of the scientific process. During his many years as a principal investigator (PI), Dr. Sullivan has mentored many undergraduate research-

ers through what he sees as the natural progression of undergraduate research: literature reviews, familiarization with the scientific method, gradual generation of technical results.

Conducting Literature Reviews



Familiarization with the Scientific Method



Generation of Technical Results

Dr. Sullivan notes that many undergraduate researchers first come into the lab with grand ideas about how they're going to change the world. And, while they certainly have the capacity to do so, he explains that he often needs to reel back these ambitions so that work can be done to build a foundational knowledge of the scientific research community and scientific method. In fact, Dr. Sullivan cites how, unfortunately, an introduction to research almost always starts with "reading a bunch of technical papers that you probably won't understand." But, despite these humble beginnings, Dr. Sullivan explains that this development of knowledge and familiarity often leads to more fruitful research contributions down the road.

Furthermore, Dr. Sullivan notes that undergraduate researchers often overcommit themselves outside of the lab. "Your research is a part-time job, it's important to focus on your schoolwork first," explains Dr. Sullivan. In many ways then, undergraduate research opportunities are an embellishment to a Mines education rather than a replacement or departure from it. Ultimately, undergraduate research is all about patience and recognizing that learning is a marathon, not a sprint.

Dr. Sullivan also points out that undergraduate research takes on several forms. While many undergraduate researchers anticipate their experience resulting in a peer-reviewed paper, this is not always the case. That isn't to say peer-reviewed papers are the only way to prove your worth as a researcher though. Dr. Sullivan explains how undergraduate researchers have left behind incredible legacies in the CFCC simply by repairing equipment, writing manuals for experimentation, or developing new models or instruments that don't lend themselves to novel discoveries. Chris Chmura (B.S. M.E. 2019), as a case in point, has done fantastic work overhauling the furnace systems of the CFCC, resulting in higher fuel cell fabrication output and, consequently, research output. And, sometimes, this is what high-impact research looks like.

“At the end of the day,” Dr. Sullivan explains, “I’m looking for undergraduate researchers that are passionate, professional, and patient.” Dr. Sullivan reminisces on how some of his most successful undergraduate researchers to date are those that come to him with spectacular plans for how to change the world, but then are willing to put in the laborious work required to produce quality technical results in the future. “It is a human problem to want to rush toward the goal,” says Dr. Sullivan. “Learning to overcome this impulse, learning to do a few things and do them well: that is the key to producing great research.”

When asked how to land an undergraduate position at Mines, Dr. Sullivan had a few words of advice for aspiring researchers:



Know your audience before you approach them; take time to look up the lab you're applying to on the internet



Work on professionalism; have your resume and cover letter ready; know where you want to go with this research



Go to the PI's office hours; they can't accidentally ignore you this way (unlike with email); persistence pays off



Be truthful about your abilities; don't act like you know what you'd be doing when you don't



Show a willingness to learn and put in the time it takes to change the world



Pay attention to the MURF announcements on the Daily Blast; it's a great way for Mines students to get involved

In the end, research is all about the “Three P's” emphasized by Dr. Sullivan: passion, professionalism, and patience. Once students learn how to fully embrace those virtues within the context of their own research style, the path is cleared for them to make substantial contributions to the scientific research community.

Consider Marcos Hernandez Rodriguez (M.S. M.E. 2019), a CFCC veteran researcher, as an example. “On [Marcos's] graduation day in 2017,” Dr. Sullivan reminisces, “he came into the lab not even two hours after graduating to work on a plumbing job for his experiment. While I by no means advocate working on your graduation day, Marcos has always been one of the best researchers at the CFCC. And, acts of passion like this just demonstrate what it is that makes Marcos such a great researcher. He is inspired by what he does and he is willing to put in the time it takes to reach his goals. He wants to make a difference in his community.” And, that goal – making a difference – is something we could all spend a bit more time contemplating how to do.

For those interested in reaching out, Professor Neal Sullivan can be reached at nsulliva@mines.edu. Professor Sullivan also serves as a member of the “Every Oredigger” culture change and steering subcommittees, and is a chair of the Mechanical Engineering Wellness committee. Thus, he is a fantastic resource for those looking to learn more about how to balance undergraduate research with a healthy experience at Mines.