

Michael L. Shuler Tribute

Contributors: Douglas S. Clark, Claudia Fischbach-Teschl, Daniel A. Hammer, Kelvin H. Lee, Julius B. Lucks, Cynthia Reinhart-King, Mark Saltzman, Abe Stroock, Marjolein C. H. van der Meulen, Jeffrey D. Varner.



Michael L. Shuler

Samuel B. Eckert Professor of Engineering, Nancy E. and Peter C. Meinig School of Biomedical Engineering, Robert F. Smith School of Chemical and Biomolecular Engineering, Cornell University, Ithaca, New York.

Mike Shuler's career has touched the professional and personal lives of countless individuals. From the undergraduates who learned the fundamentals of bioprocess engineering and nanobiotechnology, to the graduate students who helped push knowledge boundaries across length scales, to the young faculty who learned the meaning of academia, Mike Shuler's patient and thoughtful mentorship built careers and inspired greatness. We are proud and humbled to

collect the following personal reflections from a cross section of his Cornell colleagues and friends. So many individuals have been influenced by Mike Shuler's distinguished mentorship, and we hope that these personal and professional reflections adequately reflect our collective feelings toward him. A full categorization of Mike's Midas touch could fill volumes. We have tried, through the following pages, to capture and personify a career that is beyond measure, and that has contributed so much to his academic community and to society.

Respectfully,

Lawrence J. Bonassar

Daljit S. and Elaine Sarkaria Professor of Biomedical Engineering

*Nancy E. and Peter C. Meinig School of Biomedical Engineering
Cornell University*

Matthew P. DeLisa

William L. Lewis Professor of Engineering

*Robert F. Smith School of Chemical and Biomolecular Engineering
Cornell University*

David A. Putnam

Professor, Nancy E. and Peter C. Meinig School of Biomedical Engineering

*Professor, Robert F. Smith School of Chemical and Biomolecular
Engineering
Cornell University*

More Than a Mentor: An Inspiring Role Model

In the winter of 1984 my new wife, Molly, and I drove my old Chevy Nova from Pasadena, CA to Ithaca, NY (the cost of crude oil was around \$28 per barrel and headed downward; gas was \$1.25 per gallon; biofuels research was suffering). I was heading for my first job out of graduate school as an assistant professor at Cornell University. I was especially excited about working closely with Mike Shuler, an emerging leader in the dynamic field of biochemical engineering and someone I thought would be of great help to me in this new and daunting endeavor. I was expecting a scientific mentor; what I got was much more.

When I arrived at Cornell, I was indeed greeted by Mike Shuler the accomplished scholar, the novel thinker and energetic researcher, but also by Mike Shuler the family man, the affable colleague, and the kind and patient teacher that would guide me not only in conducting research, advising students, writing proposals, and teaching my first class, but in a much broader sense about how to be a better person in this

world. Mike always made time for me, and whether the topic was research, science fiction, or fishing, it was always a learning experience. Mike was the most genuine and kind teacher I'd ever had, and I will always be grateful for the impact he has made in my life.

There is an old saying about a boy and a farm. In Mike's case I would say: You can take the boy out of the Midwest, but you can't take the Midwest out of the boy. Those who have met him know what I mean. For those who haven't, if you have the chance to you'll see that he is downhome friendly, kind, and easygoing. You'll also find that he is cutting-edge sharp, visionary, and, well, brilliant. And, fortunately, a little of Mike rubs off on everyone he meets.

Douglas S. Clark
Editor-in-Chief

*Gilbert Newton Lewis Professor, Dean of College of Chemistry,
University of California, Berkeley*

Setting an Example for the Next Generation

Without Mike's vision, leadership, (and sometimes unwavering patience), the Nancy E. and Peter C. Meinig School of Biomedical Engineering at Cornell would not be what it is today. It went from non-existent to a nationally top-ranked BME program in less than 15 years. When I started at Cornell in 2007, I became part of an ambitious and fun group of 6 assistant professors that Mike hired within only 2 years and that significantly influenced what the department is today. His scientific vision of developing a quantitative understanding of human health and disease paired with his level of positive energy, persistence, and collegiality all pushed us to perform at our best. Being on the 'other side' now makes me realize how many of the laborious and time-consuming tasks he kept far from us 'youngsters'. This allowed us to develop our scientific reputation without being consumed by administrative responsibilities or the like. By organizing various retreats and trips to Cornell's medical school in NYC, he not only made sure we all met clinical leaders in our respective fields, but also that our opinions were heard and integrated in the department's path forward. His approach to leadership set an example to all of us. I remember Mike saying that he feels about us like parents about their kids. Surely, we hope that our professional accomplishments are ones that he feels proud about. I certainly wouldn't be where I am today without the support he provided.

Mike, thank you!

*Claudia Fischbach-Teschl
Associate Professor of Biomedical Engineering &
Director, Cornell Center on the Physics of Cancer Metabolism
Cornell University*

The Vision of the Single Cell

I was one of the many, many Assistant Professors who came to Cornell and has the good fortune of Mike Shuler's guidance. He generously included our lab on a project on baculoviruses that ultimately led to work from our lab on the biophysics of viral binding. It was second

nature for Mike to take Assistant Professors under his wing. Demonstrating by example, he practiced mentoring at its finest.

But the biggest effect Mike had on me was through his work. In particular, the Shuler Single Cell Model changed how I thought about cell biophysics. Mike's idea was simple—model the physiology of *E. coli* by accounting for every molecule in the cell, which allowed elucidation of interconnections in a complex system without erroneous assumptions. Mike's model is legend, and its execution has been central to the understanding of metabolic processes in biotechnology.

When I was an Assistant Professor, I struggled with the problem of how to model the adhesion of leukocytes under flow. I had trouble identifying assumptions that could be made to resolve the complex interrelationship between chemistry and force on adhesion receptors to solve the problem accurately. The way around this was to develop a simulation—now called Adhesive Dynamics—that accounted for the location and state of every adhesion molecule on the cell. The lack of assumptions made the model easy to embrace. In retrospect, I realize I was emboldened to create Adhesive Dynamics because of the triumph of the Shuler Single Cell Model.

Daniel A. Hammer
*Alfred G. and Meta A. Ennis Chair of Bioengineering &
Professor of Chemical and Biomolecular Engineering
University of Pennsylvania*

Great Teacher and Mentor

William Arthur Ward said that "The mediocre teacher tells. The good teacher explains. The superior teacher demonstrates. The great teacher inspires." When one first meets Mike, it is impossible not to be inspired and impressed. Mike visited ETH in 1995 where he gave a series of lectures on biochemical engineering fundamentals and spent many hours meeting with graduate students over coffee to talk about the future of the field. Those were truly inspirational days for us lucky enough to be there and I was grateful that Mike continued to stay engaged and interested in my personal career trajectory—a characteristic that he demonstrates for countless junior scientists that he meets and mentors.

The case can be made that Cornell University offers an incredibly nurturing environment for a junior faculty member. For a biochemical engineer like myself, this was largely attributed to Mike's mentorship, guidance, and inspiration. It's not possible to receive more wise counsel and advice than to have an office down the hall from Mike. From his regular morning pop-in to one's office while on his way to preparing a cup of tea where he would simply ask "how are things?", to more focused discussions to talk through any of a myriad of concerns that all junior faculty face, Mike's understanding of how to steer a conversation to facilitate self-understanding and learning is remarkable. Like countless others that have been impacted by his research in addition to his genius as a master teacher and mentor, I am forever grateful to Mike Shuler.

Kelvin H. Lee
*Gore Professor of Chemical and Biomolecular Engineering
University of Delaware*

Wise Mentor at a Nascent Time

I owe much of my career in Chemical and Biomolecular Engineering to Mike Shuler. I first arrived as an Assistant Professor at Cornell in 2011. Under Mike's leadership in fact, the School of Chemical Engineering was one of the first to add 'Biomolecular Engineering' to its name a decade earlier, cementing it as a center for exploring how we may understand and manipulate biological systems using the framework of chemical engineering. This was extremely fitting giving Mike's own pioneering work in bioprocess engineering, and in many ways presaged the emergence of synthetic biology that aims to discover and apply the engineering principles of biology. What an exciting playground for a young physicist turned bioengineer, and the opportunity to spread my own wings at Cornell was irresistible.

As always, once you arrive reality strikes and I have to thank Mike for being one of my key mentors as I navigated the thrills, and uncertainties, of establishing my nascent independent laboratory. High on my list of interesting challenges was introducing myself to the Chemical Engineering community, not having academically grown up in that familial culture myself. Here my wonderful colleagues, and especially Mike, gave me key insights and advice that made me feel like I had landed in the right place. Perhaps one of the most valuable pieces of mentorship Mike gave me was his conviction that my research path to understand and engineer RNA folding to regulate genes was a true 'chemical engineering' research topic, which gave me confidence that I was on the right track. I am forever grateful to Mike for those formative discussions at that early and critical stage of my career, and I hope to pay it forward myself.

Julius B. Lucks

*Associate Professor of Chemical and Biological Engineering
Northwestern University*

The Importance of Mentoring in Leadership

Successful scientific leaders forge new research paths, but more importantly they make sure that they help pave that path for those that come behind them. Not only do they inspire others, but they are some of the biggest cheerleaders of newcomers to their field. Mike Shuler has been a true leader: creating a new field of research in biotechnology, founding the Biomedical Engineering Department at Cornell University and fostering a collaborative, collegial environment that has contributed to the success of countless investigators including myself. When I first started at Cornell and did not yet have lab space, Mike generously housed my students until we were able to relocate to our more permanent home. When we needed a senior faculty member to lead the Cornell Physical Science-Oncology Center, he stepped forward to guide a 25+ member team. Whenever I needed advice on navigating the complexities of academia, he has always been happy to provide his own insights. Mike has a true knack for building consensus and identifying ways to maximize the benefit to individual faculty and the department, always maintaining an eye for the bigger goals. I am a better mentor due to his mentorship.

When I first started at Cornell, I found an old newsletter that had profiled Mike. In that article, Mike was asked if he had advice for young

faculty. His (paraphrased) advice was to always keep things in perspective and realize that there are many options in a career path. When asked, Mike relayed that if he weren't a professor, he would have chosen to be a fishing guide. I am grateful (as I am sure so are the fish) that Mike's back-up plan never came to fruition, and that he became an academic guide and mentor instead of a fishing guide. Now that he is retiring, the fish better watch out!

Cynthia Reinhart-King

*Cornelius Vanderbilt Professor, Department of Biomedical Engineering
Vanderbilt University*

In Honor of Michael Shuler

Michael Shuler was my faculty colleague from 1996–2002, when I was a professor in the School of Chemical Engineering at Cornell. He was my closest colleague, not just academically, but also physically and administratively, as we shared an office suite and an administrative assistant Bonnie. Bonnie's little dog Lance guarded the entrance to our offices. It was a productive time for me and a transformative period in my career. I know that much of this success was due to my imperfect attempts to follow Mike's model: his incredible work ethic, his unflagging commitment to his students, his calm thoughtfulness, his ability to penetrate to the core of any problem.

Mike: Thank you for the many opportunities that you presented to me, starting with your first phone call, which set me on a path to Ithaca. I am grateful for your steady advice in complex situations and your example of the impact one person can create by living a life of integrity, intelligence, and service.

Mark Saltzman

*Goizueta Foundation Professor of Biomedical Engineering, Chemical &
Environmental Engineering & Physiology
Yale University*

Generous, Unassuming Genius

I share with Mike an interest in the field he refers to as "microflu-did-ics". We've never actually collaborated; I never knew quite how. As has been his tendency throughout, he took a trajectory into this field that no one else could have imagined. Here's his trajectory as best as I can reconstruct it: the human body is complicated and pharmacokinetic (PK) models provide a useful mathematical abstraction to understand the dynamics of drugs and toxins.

Why not build a /physical/ cell culture analog (CCA) of the /mathematical/ analog of the /real/ body in order to capture some of the true cellular and molecular details while benefiting from the simplicity of the PK abstraction? So, Mike's group did just this in the mid-1990's, with little fanfare but the glimmer of interesting capabilities. In the early 2000's, when all the enthusiasm in microfluidics was for analytical chemistry and simple reactors, Mike saw a much grander

Opportunity: why not build coupled organ systems that fit in the palm of your hand to provide a sophisticated test-bed for drug

screening and toxicology? Again, Mike did just this: CCA became Body-on-a-Chip, and a new field was born. Large federal programs followed, dozens of groups joined the area, and commercial ventures emerged. As with his other innovations, Mike gets too little credit for his seminal work in this area. He does not seem to mind. He just keeps asking the non-obvious questions, patiently pursuing them, and selflessly illuminating the path forward for us all.

Abe Stroock

*William C. Hooley Director of Chemical and Biomolecular Engineering &
Gordon L. Dibble '50 Professor of Chemical and Biomolecular
Engineering
Cornell University*

What Would Mike Do?

Mike Shuler's contributions to Cornell and our College of Engineering are enormous. Others can speak to Mike's research contributions, which I know are many and significant. Who I know is Mike Shuler the visionary, mentor and gentleman.

"Mike Shuler" is synonymous with biomedical engineering at Cornell. In fact for many years, Mike was biomedical engineering at Cornell. The successful establishment of the department was not only his vision, but more importantly his perseverance and hard work. He managed the NY state approval, the College of Engineering agreement, the brokering of temporary space, and ultimately the move into Weill Hall. The vision and determination required to lead this effort from initiation through implementation were tremendous, and few individuals would have undertaken them.

When you look at who we are today, that is due to Mike. Starting with a nucleus of three people, not even three full faculty lines, Mike hired an excellent cadre of junior faculty to nucleate and grow biomedical engineering at Cornell. He nurtured and developed these individuals in a department in which he was the only 100% effort full professor. Through individual and group meetings Mike grew promising young researchers into academic leaders. Throughout he modeled respectful dialogue and behavior. As his successor in the front office, I cannot even tell you how often I think: What Would Mike Do... to recruit faculty candidates?... to mentor junior faculty?... to

negotiate space with the administration?... and the list goes on. Mike did it so very well.

Marjolein C. H. van der Meulen

*James M. and Marsha McCormick Director of Biomedical Engineering &
Swanson Professor of Biomedical Engineering
Cornell University*

The Shuler Rule

My first exposure to Mike and his work came during my graduate studies at Purdue. I implemented the Domach and Shuler single cell *E. coli* model, and several of the follow-on eukaryotic modeling studies. I was amazed by the beauty and scope of these models. Mike was thinking about genome scale events at the level of a single cell, and the integration of gene expression and chromosomal replication with metabolism, long before the *E. coli* or eukaryotic genomes were sequenced, or we had access to the large scale metabolic reconstructions that are common today. Given this massive contribution to the field, I carried, as it turns out, an incorrect impression of Mike into my interview at Cornell. I expected a towering and imposing figure, and while Mike is certainly a tall man, he put me at ease during our discussion. He was warm, and humble about the tremendous contributions that he has made to biochemical engineering, and later to biomedical engineering, first through his own animal on a chip work, and later as the first director of the Department of the Biomedical Engineering at Cornell. Beyond his scientific accomplishments, as a colleague, I've learned one of the most important lessons anyone can share from Mike; do your best, hire good people, and don't worry about funding, it will come. We call this the "Shuler rule", and in the uncertain funding landscape that is the reality of modern academics (especially for modeling and computational research), this advice has proven to be correct. Thank you for everything, Mike!

Jeffrey D. Varner

*Professor, Robert F. Smith School of Chemical and Biomolecular
Engineering
Cornell University*