

Dear Fellow Faculty,

It is bittersweet to join you all today to remember our dear colleague Daniel I.C. Wang, Institute Professor and a member of our Chemical Engineering Department, who passed away on August 29 of this year. It is hard to state in a few words the legacy left by Professor Wang, or “Danny” as he was known to generations of advisees, mentees, and friends. Danny was a giant in the field of biochemical engineering, and indeed he is widely acknowledged as one of the founding fathers of the discipline. His groundbreaking research in bioprocessing, enzyme technology, and mammalian cell cultures set the stage for the modern biotechnology industry and for many of the advanced pharmaceuticals that are saving lives today. His work was an example of the highest and best aspirations of engineers, and we are all better for it.

Danny Wang was born in Nanking, China before coming to the US for his studies, where MIT very wisely offered him admission as an undergraduate. He arrived in 1955 and majored in Chemical Engineering as an undergraduate. In the mid-century, our discipline was still heavily engaged with much of the research that underpins the petrochemicals and traditional chemical industries, and biochemical engineering was still considered something of a novelty. Nonetheless, some of the earliest work in understanding and manipulating biologically derived systems had begun in the field, and what was known then as the Food and Nutrition Sciences Department at MIT was also doing work in the fields of bioreactors and fermentation. Danny, from his earliest studies, bridged these two worlds, staying on to complete a master’s thesis in Food and Nutrition Science, measuring dissolved oxygen activity in continuous fermentation, which he completed in 1961. He then completed his PhD in Chemical Engineering at the University of Pennsylvania in 1963, with Professor Arthur Humphrey, on high-temperature short-time sterilization. He then served two years in the US Army at the US Army Biological Warfare Laboratories at Fort Detrick, Maryland, which significantly broadened his experience in both fermentation technologies and the nascent field of animal cell culture. In 1965, MIT was again both wise and fortunate to persuade him to rejoin us as a faculty member in Food and Nutrition Sciences, which later became the Department of Applied Biological Sciences. James Wei, who served as Department Head from 1977 through 1988, remembered Danny as “someone with both the intellectual prowess and charisma to be a bold leader”. With his encouragement, in the early ‘80s Danny officially joined the Department of Chemical Engineering, pushing the department further into the field of biochemical engineering. This led to the establishment of courses and training in the Department that was central to bioreactor design and formed the foundation of the metabolic engineering and, ultimately, synthetic biology fields. Danny also played a formative role in American Institute of Chemical Engineers’ Society for Biological Engineering. We have been truly honored to count him in our ranks for the last forty years.

In his work, Danny trained many outstanding graduate students, including our own (now) post-tenure faculty member Charlie Cooney, who went on to partner many times with Danny at the frontiers of the biochemical engineering field. Other students of note include Andreas Bommarius at Georgia Tech and Noubar Afeyan, Founder of Flagship Pioneering. Important collaborators with Danny include George Whitesides at Harvard, and MIT’s Tony Sinskey, Arnold

Demain, Clark Colton, and others who would become longtime collaborators. He helped launch a large initiative for cellulosic biomass conversion, aimed at advancing biofuels at a time of rapidly rising petroleum and gas prices. Throughout his early projects, Danny maintained an interest in animal cell culture, publishing a paper on microcarriers for not only animal cell cultivation but also virus production as well as interferon synthesis. By 1980, recombinant DNA technology was seen as transformational, and the production of many new human therapeutics was becoming real.

In the early '80s, Danny was the driving force behind the formation of MIT's Biotechnology Process Engineering Center, known as BPEC, which brought together engineers and scientists from across the disciplines to advance this technology, and he served as its Director from 1985 to 1998. Early problems with making recombinant proteins using *E. coli* demonstrated the need to use animal cells as a manufacturing method, and the platform that Danny began developing in the late '60s became the platform for manufacturing many of the important biologics in use today. In the '80s, Danny's lab became a powerhouse of innovations in this field, solving critical problems in improving cell cultivation with microcarrier technology, growth medium design, process monitoring, and bioreactor design. He also created a means of lifelong education through a summer short course on these topics that was the longest running and most successful in MIT's history.

Danny always had an uncanny ability to see the big picture of where the field was going, and the impacts of Danny's research are found in every sector of the biotech and pharmaceutical fields today. He was named Institute Professor of MIT in 1995 in recognition of these contributions, and was also elected to the National Academy of Engineering and the American Academy of Arts and Sciences. Danny received many awards over the course of his career, among them the Amgen Biochemical Engineering Award in 1995 and the William H. Walker Award from the American Institute of Chemical Engineers in 1994. In 2000, Professor Wang was given the Temasek Professorship at the National University of Singapore where he devoted part of his time toward helping Singapore in their biomedical science research and development.

It is not an understatement to say that his work has improved countless human lives.

But we do not only remember Danny as a brilliant scholar: we also remember him as an inspired and extremely engaging teacher and mentor. As Jean-Francois Hamel remembered, "Danny was a born storyteller, conveying his vast knowledge with a passion and creativity that stuck with his students." Danny loved a good debate, and he always challenged his students to truly understand their arguments and think them through to the possible implications. As Bernat Olle, one of Danny's later PhD students in 2007, remembers, "He would straighten me when I was unfocused, help set clear crystal goals and push me to meet them, and raise the bar way higher than I thought I could hit. Never during the thesis have I had the impression of even coming close to meeting his standard, but it has been a worthy goal to strive for. Danny always did things based on what was best for his students, never for himself." Danny's alumni truly loved him, and they showed their appreciation: in 2014, the Daniel I.C. Wang Professorship was established in Biological Engineering in acknowledgement of his seminal role in the

development of the discipline, and the Daniel I.C. Wang Lecture was established in Chemical Engineering to bring in leading lights in the field. Noubar Afeyan, Danny's PhD advisee in 1987 and a Corporation Member, made the lead gift in this effort and said of Danny, "(He) touched thousands all over the world by inspiring generations of students, industrial collaborators, and fellow professors. He was confident yet humble, tough yet caring, serious yet playful, with an insatiable appetite for good Chinese food." Danny's alumni are his living legacy in the world, and they will carry his research to fields and frontiers we can't imagine today.

I will personally always remember Danny as a faculty mentor when I joined the Department, and I consider myself fortunate to have had the chance to experience, for myself, Danny's kindness, his wisdom, and his humor. He was tough and demanding, because he knew to expect the most out of those who worked with him, and he was able to challenge us all to perform at our highest levels. He was also caring and passionate, and like many decisive leaders, he never held back on his opinion! I will miss Danny Wang, my colleague and friend, but I join the Institute in feeling profound gratitude that he chose to make us his home for more than 50 years. Please join me in a moment of silence for Danny.

[Presented by Professor Paula T. Hammond, Head, Department of Chemical Engineering]