Yongmin Kim

By Jessica P. Johnson

Setting the Pace for Bioengineers

Early in his career, Yongmin Kim adopted an interdisciplinary approach to research that a more ego-driven researcher would have shied away from. He teamed with statisticians, electrical engineers, medical doctors, computer scientists, and industry executives to produce a steady stream of around 450 publications and a slew of innovations to medical imaging equipment that he has often had the pleasure of seeing put to use in hospitals in as short as two years. But Kim did not sit back and bask in his accomplishments. The moment he reached a goal, he set his sights on the next one. Having helped build the University of Washington's Bioengineering Department, where he led students and faculty for 29 years, the IEEE Fellow and former Engineering in Medicine and Biology Society (EMBS) president resigned his tenured faculty position and set out to meet another challenge: serving as president of South Korea's Pohang University of Science and Technology (POSTECH).

Though he spent nearly three decades at the University of Washington, Kim's colleagues and former students aren't surprised by such a big move. On the contrary, Vikram Chalana, chief technical officer of Winshuttle and Kim's Ph.D. advisee in the early 1990s, says, "I would have been surprised if he had retired, because I couldn't picture him as retired. His father was an academic and

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an administrator and he knew he wanted to follow in those footsteps."

Kim's academic drive and interest in bioengineering emerged at a very young age. "Around 1960," says Kim, "my Dad brought a book from his school library about the submarine named Nautilus that went under the Arctic Circle without surfacing. It was the first nuclear-powered submarine in the world. I couldn't read English at the time, so I just looked at the pictures—it was fascinating. I asked him how I could learn to do those kinds of things."

"Electrical engineering," was his father's reply.

"I said, 'Great, I want to be a professor in electrical engineering when I grow up.' So at age seven or eight, I formed that goal in my life," says Kim. It was the first of many high bars that Kim would set for himself.

His father encouraged his pursuit throughout elementary and high school and into the electrical engineering program at Seoul National University. There, Kim began to feel drawn to a slightly different discipline—bioengineering. "I was interested in how insects communicate with each other," says Kim. "How do [lightning bugs] produce light? They don't have any batteries inside. So I became interested in biomimetics and applying these techniques to medicine."

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After a brief stint in the Korean military, the interest originally piqued during his undergraduate study led the newly married Kim to the University of Wisconsin, Madison. There, he pursued his master's and Ph.D. degrees under the guidance of Willis Tompkins and John Webster, two electrical engineers who had also turned to biomedical engineering. "I had the opportunity to go to the University of Wisconsin Hospital to observe 30 or 40 surgeries and collect data," Kim says. "So I understood how engineering technologies were being used at that time, particularly in the operating room." Together, the men created a three-dimensional computer model of the human body and designed algorithms to improve electrical impedance tomography, a technique in which small currents are sent through the body by electrodes attached to the skin. The currents are altered by the different densities of tissues within the body, providing data that is processed to create an image of the organs inside.

By the time he graduated in 1982, Kim had only a few publications and conference presentations, a number that, today, would attract no interest from potential employers. He was determined to continue on the path he had begun in Wisconsin, the development of medical imaging devices. "I sent out 100 job applications to universities around the United States and got 50 interviews. But I couldn't do them all, so I chose 16 and got 13 offers. I don't know what attracted them to me," he says. "If I submitted that resume today, I wouldn't have gotten any interviews. The number of publications that you need to get interviews has increased exponentially."

Kim, his wife, and their two young daughters set off to the University of Washington because it had what he believed was the best bioengineering program of the schools that sent him offers. "I found that the researchers and medical doctors there were really collaborating, rather than a master/slave relationship where the doctors are the masters and the researchers are the slaves."

Within a month of his arrival, Kim was called to a meeting by Robert Rushmer, an early pioneer of ultrasound devices and a founding director of the University of Washington's Center for Bioengineering. Rushmer was charismatic and well respected, so although Kim had little idea what to expect, he accepted the invitation. When he entered the room, he found a biomedical engineer, two cardiologists, and representatives from a bioengineering company seated at the table. Rushmer sketched out a problem on the blackboard: how to determine the optimal placement and power output of defribrillator paddles to minimize the risk of burns to the patient. "Rushmer said, 'Discuss how to solve this problem and don't come out until you have a solution,'" Kim recalls. They didn't have a solution by the end of the meeting, but Kim got research funding from what is now Medtronic's Physio-Control and, through continued interdisciplinary collaboration, they solved the problem just two years later.

"That experience really connected me to the bioengineering community and to the hospital," says Kim. "The most beneficial thing to me was working with collaborators, particularly medical doctors. It gave me the opportunity to know what was needed clinically so I could use engineering to solve the problem." He says he has seen many cases where researchers make the wrong assumptions about what's clinically important because they haven't consulted clinicians. In the end, the results aren't useful because they address theoretical problems, rather than real-world problems, with the medical systems. "It's really exciting when you see your research results used in the medical industry," he says.

With this first real taste of the successes that the diverse collaboration could offer, Kim dedicated himself to interdisciplinary research. He found that the University of Washington provided an encouraging environment for such endeavors. "Thirty years ago, Seattle was a very remote place. So if you wanted to do something, you really had to work with people

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locally," says Matthew O'Donnell, dean of engineering. "And that created this culture that has not gone away and it has even gotten better."

Kim went on to work extensively with industry during his tenure at the University of Washington. Focusing on next-generation ultrasound imaging systems, he partnered with companies like Texas Instruments, Hitachi Medical, Samsung, Siemens Medical, Canon, IBM, and Verathon. "I believe collaboration with industry is essential if we want to maximize the chances of our research being put to use to benefit the public." He admits, though, that it can be a challenge to work with industry within an academic setting. "Our missions and operating characteristics are different. In academia, we prefer looking for new knowledge, so we have a long time line. Industry has milestone-driven project management schemes. They have to pay attention to the bottom line."

"In academia, you can give a grad student a very risky project," Kim explains. "There is some possibility that they might succeed, but much probability that they might fail." In the 1990s, Kim worked with Siemens on a problem that the company couldn't justify pursuing internally because of the high potential for failure in the short term. In 1996, Kim and his grad students solved the problem, and Siemens was able to introduce a new ultrasound machine. "In industry, they are very good at development, but they cannot handle new technology. The VP in charge of the ultrasound business told me that if this was an internal project it would have been canceled several times along the way."

"The people who are in the ultrasound world, they'll tell you that the thing Yongmin is able to do is take this idea of advanced computation and algorithms and computer architectures and not just throw them into an imaging system to make it faster or cheaper, but to tune it to address a specific clinical problem," says O'Donnell. "That's where his expertise is and his creativity."

Because of his collaborations, Kim now claims credit for more than 80 inventions, 70 patents, and 25 commercial licenses. Seeing his research used on a daily basis to improve the quality of patient treatment is one of Kim's proudest achievements. For Siemens, Kim developed three-dimensional ultrasound technology and a programmable ultrasound machine. With Hitachi, he and his team developed several new ultrasound machines in addition to real-time tissue elastography, an algorithm that collects ultrasound data and displays real-time results of varying tissue elasticity. Abnormal elasticity can indicate cancer. He is also working to develop a technology to diagnose coronary artery disease by detecting differences in the sonic vibration of arterial walls caused by the presence of plaques. Efforts are underway to produce diagnostic medical devices for use at home and in developing countries that have little access to expensive equipment. The concept, called *distributed diagnosis and home health care* (D2H2), focuses on building smaller, cheaper, and portable ultrasound units that are more efficient than current models.

In 1996, his advances in the field earned Kim a distinction that had been another of his long-term goals—to become an IEEE Fellow. As a graduate student in Wisconsin 20 years earlier, he says, he frequently read journal articles authored by researchers whose names were followed by the curious title of IEEE Senior Member or IEEE Fellow. He soon learned that it was a really big deal because it denoted a person with an extraordinary record of accomplishments in any of the institute's fields of interest.

By the time he left the University of Washington in August, Kim was a tenured professor of electrical engineering and bioengineering, an adjunct professor of computer science and engineering and of radiology, had served as the bioengineering department chair for eight years, and started the university's Image Computing Systems Laboratory—dedicated to

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developing algorithms and ultrasound imaging systems with clinical applications. In July, he earned the 2011 EMBS Morlock Award "for outstanding technical contributions and leadership in developing high-end programmable digital signal processors and applying them to medical imaging."

But technology development was only half of Kim's job. Improvement of his department and the quality of education its students received were equally important to him. Kim pioneered the University of Washington's undergraduate program in bioengineering, which is now ranked one of the best in the nation. "Bioengineering is a very interdisciplinary and demanding area," says Lee Huntsman, former director of the bioengineering department and the current University of Washington president emeritus. "In the 1970s, the University of Washington bioengineering department was a relatively unknown component of the university. Now, it is one of the jewels in the crown. It takes time, energy, and good leadership. You have to have a compelling story, be persuasive and persistent. Yongmin has been extraordinarily successful in helping to move the department forward and I have enormous respect for his ability to do that."

Kim's high standards and tireless pursuit for the next goal is a quality he tries to impress upon his students. Their success gives him a satisfaction equal to that of seeing his research directly applied to improving patient care. "Yongmin's most striking legacy was the huge number of capable students in his lab," said David Haynor, professor of radiology and a long-time collaborator. "He had up to 20 students in his lab at a time. Nobody else in the department had that number. If you figure you need about 30 minutes per week with each student, that's an enormous amount of time. It was amazing to me that he was able to keep on top of as many projects as he did, and to keep the projects moving ahead."

"Probably his biggest contribution was bringing multiple disciplines together," says Chalana, whose Ph.D. advisory committee included a surgeon, a radiologist, a statistician, and a computer science professor in addition to Kim. "Every time we would meet, he would have a lot of feedback. He had a lot of stuff on his plate, but he made sure he had time for students. He has a reputation to be very strict and have very high expectations, so a lot of students were afraid to work for him. But that's what I was looking for—someone to push me."

"There were other professors in the department at the same time who were also intense and made their students do a lot of work," says Haynor, "but the students in Yongmin's lab were on the whole much happier."

Chalana says that Kim always directed his students toward projects that could help solve pressing problems. Chalana found it highly satisfying to see some of those solutions put into place while he was still in grad school. "The students have 30–40 years of a professional career in front of them," says Kim. "They should focus not only on their personal success, but on what they can do to improve people's quality of life, particularly in developing countries. If you set your goals high, have the strength and courage to build on strong technical knowledge, and press on against naysayers and detractors, you should be able to reach your goals and beyond." Though Kim has resigned from the University of Washington, he plans to mentor his remaining students until they graduate, just as he continues to mentor and collaborate with those who have already graduated.

For Kim, whose four-year tenure as POSTECH's sixth president began on 1 September 2011, his departure from the University of Washington was bittersweet. "In August, I spent a week cleaning up my office at the U-Dub," says Kim. "I threw away about 90 percent of my things. It gave me a lot of time to reflect on the people who have helped me. In one sense it was sad to leave my friends and collaborators, but on the other hand, I am thankful that after 29 years, I have this second opportunity to lead POSTECH and make it a greatly improved institution in the next several years."

"Everyone here felt his leaving was a tremendous loss," said Haynor. "I am sad to see him go, but I don't blame him—it's a tremendous opportunity." Kim believes he can have a bigger impact in the field of research science by leading POSTECH's large group of faculty and students. Being only 25 years old, the university has reached a high standing among other Asian universities and is poised to grow significantly through grants and industry partnerships in the next few years. Kim says he isn't sure where he'll end up after his presidency, but he is sure about one thing—that he'll continue to advise students and colleagues engaged in bioengineering research.

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