Endowed Professorships & Directorships at Stanford School of Engineering

THE HONG SEH AND VIVIAN W.M. LIM PROFESSORSHIP IN THE SCHOOL OF ENGINEERING

AN ENDOWED CHAIR is an enduring testament to intellectual and philanthropic values. It represents a commitment to academic excellence and independence.

With their gift to the Stanford School of Engineering, Hong Seh and Vivian Lim join an honor roll of individuals who enable university leaders to shape a professoriate of renowned scholars who strive to advance humanity.

Similarly, Professor Krishna Shenoy joins a roster of highly distinguished faculty members as an inaugural chair holder. His innovative research, which blends a deep understanding of signal processing and neuroscience with techniques to build clinical innovations, makes him a welcome addition to our cadre of named professors.

The Hong Seh and Vivian W.M. Lim Professorship in the School of Engineering will benefit untold generations of students and the world at large. Stanford is deeply grateful to Hong Seh and Vivian, whose vision and generosity make this possible.

JENNIFER WIDOM
The Frederick Emmons Terman Dean of the School of Engineering
The Fletcher Jones Professor in Computer Science
Professor of Electrical Engineering

HONG SEH AND VIVIAN LIM

Hong Seh Lim is the founder and president of Mil Kered Inc., which develops and manages both commercial and residential real estate. Previously, he was with Calera Recognition Systems and IBM, doing research in character recognition and computer vision using artificial intelligence.

Named to the board of directors of Trans Pacific National Bank of San Francisco in 1999, Lim has also served on the board of Self-Help for the Elderly, a senior service organization based in San Francisco. At Stanford, Lim is an active member of the SIEPR Advisory Board and of the Dean's Research Council, and serves as a mentor for the LEAD (Lifelong Engagement and Advocacy for Development) Council. He has previously served on the Engineering Advisory Council; the Athletic Board; and along with his wife, Vivian, the Parents' Advisory Board. He received the 2015-2016 Stanford Associates Governors' Award in recognition of his exemplary volunteer service to the university over an extended period.

Hong Seh earned a BSc from the University of Hong Kong. From Stanford, he has MS degrees in Operations Research, '83; Electrical Engineering, '83; and Computer Science, '87, as well as a PhD in Electrical Engineering, '87.

Vivian received both her bachelor's and master's degrees in Electrical Engineering from Stanford in 1982. She was employed with Monolithic Memories, which later merged with Advanced Micro Devices. She specialized in programmable logics devices and application-specific integrated circuits. After having four children she decided to become a full-time mom. She was an active volunteer with her children's school and organized many school functions and swim meets. Vivian recently designed the Stanford Golf Club 18-Hole Women's Section website, which provides online tee time sign-ups and score-keeping for group members. She continues to actively work as the website's webmaster.

The Lims have four children, all Stanford alumni: Derek, BS in Product Design and MS in Management Science and Engineering, '12; Maxine, BS in Computer Science, '13; Stephanie, BS in Product Design, '14, and MS in Mechanical Engineering, '16; and Ted, BS in Computer Science, '17.

KRISHNA V. SHENOY

KRISHNA V. SHENOY, professor of electrical engineering and, by courtesy, of bioengineering and of neurobiology, joined the Stanford faculty in 2001. He exemplifies the spirit of interdisciplinary research and teaching by pursuing basic neuroscience, fundamental engineering, and clinical translation of a new class of medical system termed brain-machine interfaces, designed to help people with paralysis.

Born in Kansas to an Indian immigrant engineer father and an American high-school teacher mother, Shenoy grew up in Iowa farm country and then headed west for college. After completing his undergraduate degree in electrical engineering at the University of California, Irvine, in 1990, he pursued electrical engineering during his graduate studies at MIT, focusing on optoelectronic materials, devices, and circuits. During this time his fascination with how many simple parts (transistors) can be assembled to form complex systems (computers) grew to include the question of how many neurons can be assembled to form the brain and our mental lives.

After obtaining his PhD in 1995, he headed west again, this time to stay, to pursue this interest by training to conduct neurobiological experiments and computational modeling as a postdoc at Caltech. There he started to conceptualize bringing systems neuroscience and electrical engineering together, to enable reading information (movement intentions) from the brain and writing information (sensory signals) to the brain. If this were possible to do in real time and with low power, and it could be scaled and made safe, it could create a new class of medical system termed brain-machine interfaces (BMIs). BMIs could help people with a wide range of neurological injuries and disease.

In 2001 he joined the Stanford faculty as an assistant professor to pursue this nascent concept and help establish this fledgling interdisciplinary field. He proceeded to assemble the Neural Prosthetic Systems Laboratory, composed of electrical engineers, neuroscientists, bioengineers, computer scientists, neurosurgeons, veterinarians, and technicians. Here they investigate the basic neuroscience of how populations of cortical neurons compute and control arm movements, as well as how to design high-performance algorithms and build complete electronic systems to translate this language of the brain into electronic control signals to guide computer cursors and prosthetic arms. They established a new way to understand how populations of neurons coordinate and cooperate to compute and control arm movements by using a dynamical systems perspective and formalism. They also designed and demonstrated generations of the highest performing BMIs using new estimation and control algorithms.

In 2009 he, together with Jaimie Henderson (head of functional neurosurgery at Stanford), formed the Neural Prosthetics Translational Laboratory to translate BMIs from the lab to the clinic. Their clinical trial research has designed and demonstrated the highest performing BMIs for people with ALS, upper spinal cord injury, and other forms of severe paralysis. This has helped motivate the recent surge of interest in transferring this technology to industry.

His work has been recognized in various ways, including with a Sloan Fellowship, a McKnight Technological Innovations in Neurosciences Award, an NIH Director's Pioneer Award, serving as a Fellow of the Defense Science Research Council (DARPA), election to the Henry Samueli School of Engineering Hall of Fame at UC Irvine, election to the American Institute of Medical and Biological Engineering, and appointment as an Investigator of the Howard Hughes Medical Institute. Most meaningful to him, though, was receiving the 2010 Stanford Postdoc Mentoring Award. He is particularly proud of the accomplishments of his students and postdocs, who are now leaders in academia and industry.

He is also active in transferring technology to industry. In addition to publishing numerous papers and having numerous issued patents, he serves on the scientific advisory boards of the University of Washington's Center for Sensorimotor Neural Engineering (an NSF Engineering Research Center), Cognescent Inc., and Heal Inc. He is also a consultant for Neuralink Inc.

KRISHNA SHENOY'S THOUGHTS ON BEING THE INAUGURAL CHAIR HOLDER

I AM HONORED to be selected as the inaugural holder of the Hong Seh and Vivian W. M. Lim Professorship. I would like to express my sincere appreciation to Mr. Hong Seh Lim and Ms. Vivian Lim for this endowed professorship. Their support is especially meaningful to me given their long relationship with Stanford, beginning when they were students and expanding to now include their four alumni children.

To move things is all mankind can do, for such the sole executant is muscle, whether in whispering a syllable or in felling a forest.
—Charles Sherrington, 1924

We tend to forget that all we can do to interact with the world is to move. Millions of people suffer from neurological injury or disease, resulting in paralysis. When this happens, we appreciate just how central movement is in our daily lives. We reach and walk by moving, we eat and breathe by moving, and we even speak by moving. Our entire ability to express our mental lives and tend to our physical needs is enacted by sending electrical pulses from the brain, through the nervous system, and on to the muscles.

Stay hungry, stay foolish.
—Steve Jobs, 2005
(Stanford Commencement)

But what if we could change that? What if we could express ourselves and tend to our needs not by sending signals from the brain to the muscles, but instead by eavesdropping on brain signals, interpreting these signals which contain our intentions to move, and using this information to guide prosthetic devices. Prosthetic devices including prosthetic arms, computer interfaces, and the rapidly expanding internet-enabled world around us (i.e., internet of everything). If this can be done safely, offer real quality of life improvement, and be affordably provided to patients, then this new class of medical system (so-called brain-machine interfaces, or BMIs) offers new hope for millions of people.

BMIs may just now be possible due to a serendipitous confluence of four rapidly advancing areas: neuroscience, neuroengineering, clinical translation, and technology transfer.

Neuroscience. The brain is a complex place. It is often referred to as our last great frontier. Learning how it functions is not only of great biomedical science and engineering interest, but it is also a profound human endeavor. President Obama emphasized this by launching a decade-long BRAIN Initiative to accelerate this quest. But do we know enough already to get started with listening in on brain activity, as well as subtly altering brain activity, for therapeutic purposes? Yes, though we are far from fluent in understanding the language of the brain, we are minimally conversant. More specifically, we know a reasonable amount about—and continue to advance in our lab and others'—how populations of neurons in the brain coordinate and cooperate to guide arm movements that are remarkably swift and accurate.

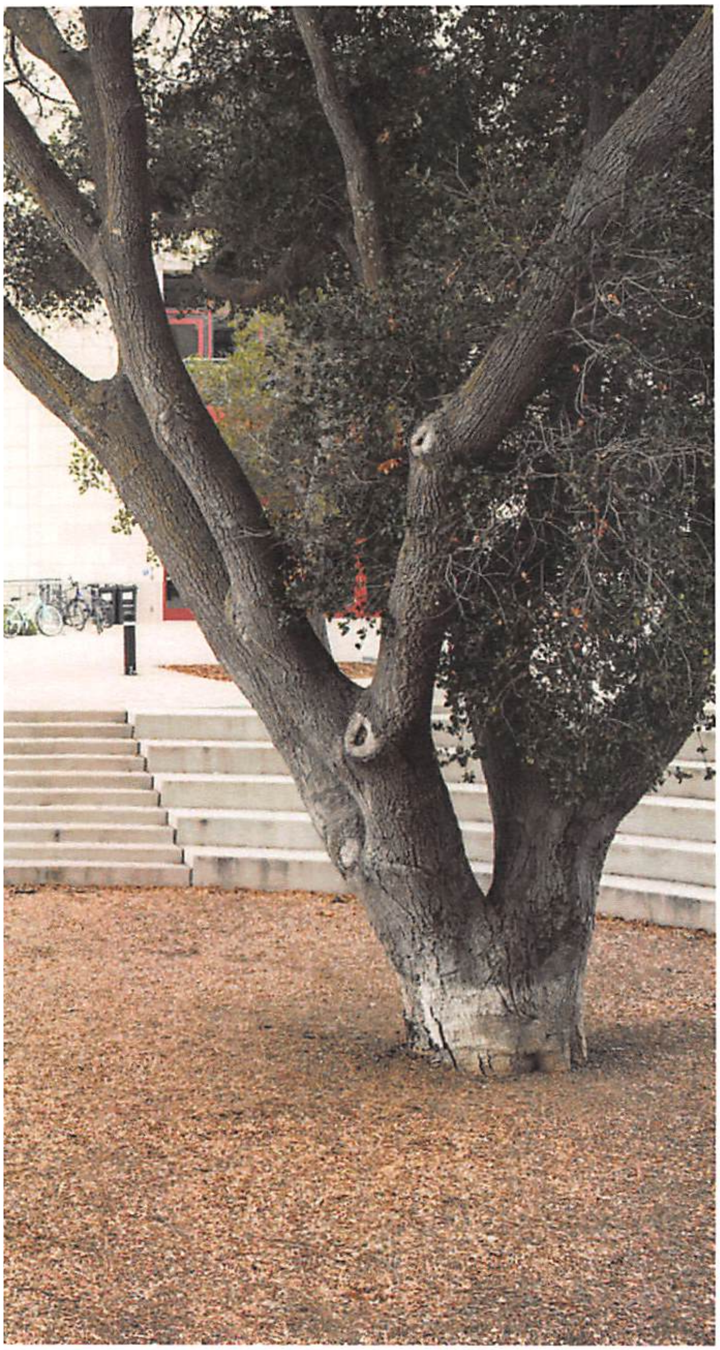
Thus we now understand the relationship between electrical signals from the brain and movements well enough to form a solid foundation on which to build BMIs.

Neuroengineering. Measuring, perturbing, and decoding neural activity requires many of the fruits of the ongoing microelectronics and information revolution. Microelectromechanical systems (MEMS), microfabrication, and low-power integrated circuit technologies are essential for creating micron-scale electrodes for measuring minute electrical signals from hundreds and thousands of individual neurons (i.e., "reading out information"). Electrical and optical technologies are vital for altering neural activity in neurons so as to provide, for example, surrogate sensory information such as the sense of touch from sensors on a prosthetic hand (i.e., "writing in information"). Finally, a range of information systems technologies are central to analyzing large amounts of neural data and designing optimal real-time decoders that convert signals from the brain into digital signals for controlling prosthetic devices. This is the main thrust of our engineering research, including dynamical systems, estimation, control, optimization, and machine learning. Silicon Valley's prominent and ever accelerating role in advancing a broad base of technology is essential to the feasibility and progress in BMIs. Our efforts benefit greatly by being here at the heart of this wellspring.

Clinical translation. We are all too familiar with hearing that yet another pharmaceutical or medical device failed a clinical trial. While there are many reasons for this, safety and efficacy are the centerpieces. With BMIs being essentially entirely new, we wanted to tackle these questions head on. To do so, Jaimie Henderson (head of functional neurosurgery) and I established and co-direct Stanford's Neural Prosthetics Translational Lab. Our FDA pilot clinical trial focuses first on the safety of neurosurgically implanted MEMS sensors. Together with our multi-site clinical trial partners, over 15 people with paralysis have been enrolled and collectively have participated for many tens of person-years. Our second major focus is efficacy, and more specifically the key question that often impedes clinical trials: Does the pre-clinical research that is done with a model system capture the essential aspects of the human condition (ailment) being targeted? In my main research group (Stanford's Neural Prosthetic Systems Lab), we have reported a succession of algorithms and systems designs resulting in world-record performance. We found that these designs based on a model system do indeed translate well to people with paralysis (ALS, upper spinal cord injury). More specifically, decode algorithms that work better in our model system also work better with our participants with paralysis (e.g., using numerous applications on computers and tablets, including typing messages and using web apps). Moreover, the speed and accuracy of prosthetic device control is in the same range and is high enough in absolute terms to begin to improve quality of life. We believe that the combination of basic neuroscience and neuroengineering research together with translational clinical trial research is a powerful and unique platform for carefully yet rapidly bringing BMIs out of the lab and into clinical reality.

Technology transfer. As with all innovations, BMIs can only impact society if they are transferred to the commercial sector. While the field of BMIs is still relatively nascent, cochlear implants for the profoundly deaf and deep brain stimulators for people with Parkinson's disease have become standard of care and have a thriving industry. But can BMIs that interface with larger portions of the brain, to read out and write in signals, achieve commercial viability given their relative complexity that pushes boundaries such as implanting electronics and wireless transceivers on the surface of the brain? I believe the answer will be yes, but time will tell. Encouragingly, in the past year three new efforts have formed to pursue this vision: Kernel, which is a startup; Facebook via their Building 8 research division; and Neuralink, which is a startup founded by Elon Musk and with which I am involved. Time will tell if this is when BMIs take hold and find increasing widespread applications and adoption.

It is a pleasure to pursue this research and teaching at Stanford, which strongly promotes multidisciplinary endeavors and supports it through its broad-based strengths and resources. I am grateful to be the inaugural holder of the Hong Seh and Vivian W. M. Lim Professorship, and to Hong and Vivian personally for their vision and foresight to support long-range research including its inherent challenges. This professorship will enable many new directions of BMI-related investigation and will invigorate new generations of students and postdocs in their own pursuit of research impacting health and society.



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Ensuring Stanford Engineering's continued excellence and leadership, endowed chairs provide financial stability to the university and the school. The donors who make these possible are an elite group of Stanford's most visionary and generous friends.

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