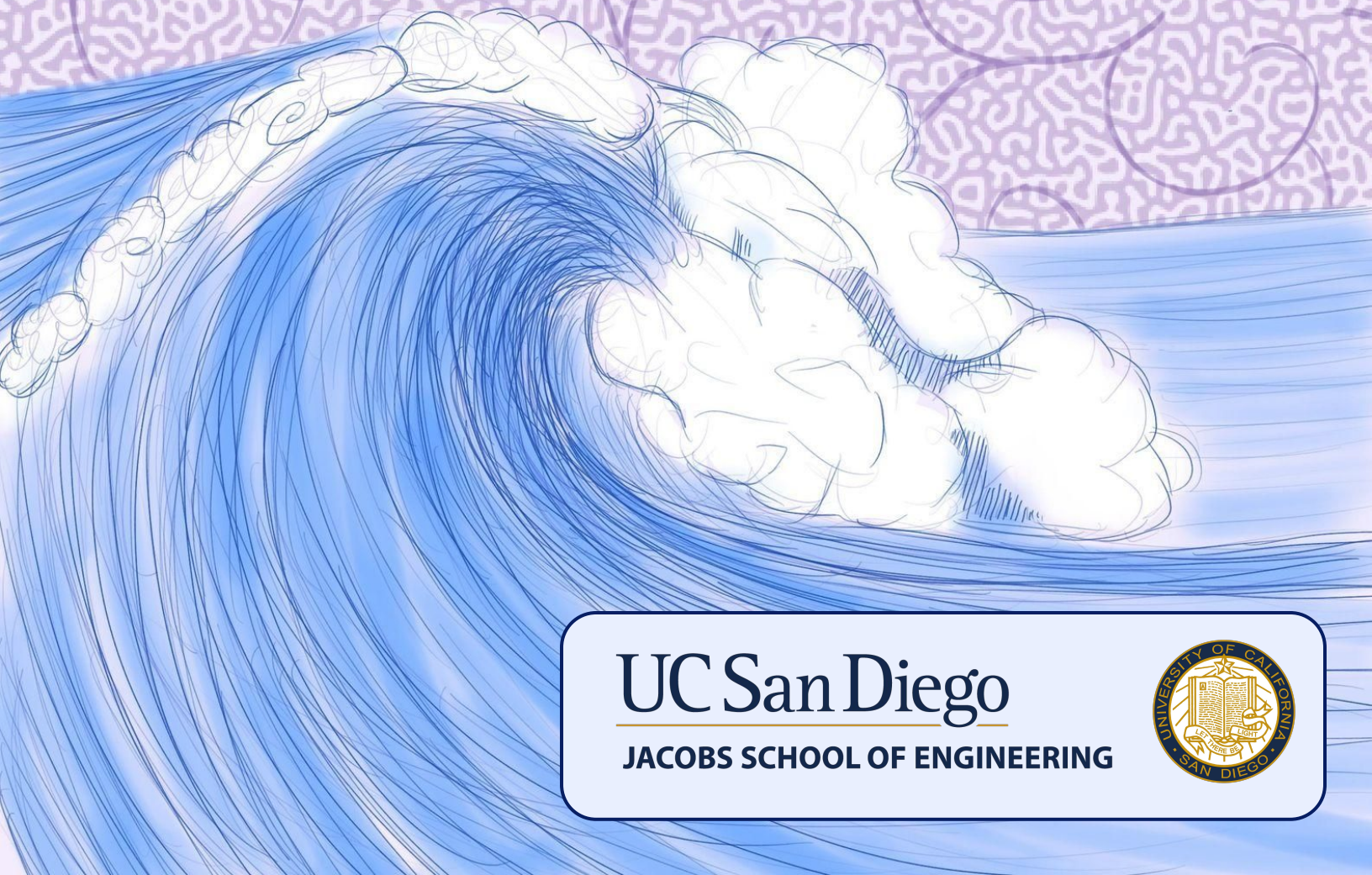
Spring 2022

BioEngineering Newsletter



UC San Diego

JACOBS SCHOOL OF ENGINEERING

Spring 2022

On the same [brain] wavelength, translational medicine, and building [neural] networks

The People of BEN

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Features.....The BENG Class of 2022

Interviews..... Nicholas Sada, Romina Shirazi, Meenakshi Singhal

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The BioEngineering Newsletter (BEN) is a student run publication that covers the people, research and events within the UCSD Bioengineering community. We conclude the academic year with a special message from the **graduating Class of 2022.** As always, the **Spring 2022** issue is dedicated to celebrating the resilience and ingenuity of our peers.

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Features

Chrysanthemums and a Bee, by Hokusai (c. 1831)

To future bioengineering classes:

Advice from the Class of 2022

Curated by BEN Staff

Don’t think too hard and follow what your heart desires, even if it’s not the path you’re following so far!

The field you may become a leader of might not have even been established yet. Keep an open mind and stay receptive to the opportunities around you, because your perspective on the world can make all the difference.

Make friends in your classes because the camaraderie that you build helps you survive all the classes.

Don't let numbers define who you are!

If you have other career interests outside of bioengineering, try your best to pursue them.

Take as many "fun" classes as you can. In bioengineering, we have very limited opportunities to take classes outside of our major so make the most of it.

1. Join the BEN. It’s a tight community supported by wholesome people.

2. Don’t worry if you don’t know your future career choice. Things change. Just learn how to learn, keep yourself productive and become good at something.

Get used to teaching the entire class to yourself. Make sure to balance work and life, and give yourself time to relax.

Make sure to form study groups and make friends, take advantage of any IDEA center programs to get research and internship experience, and have fun.

Bioengineering Day 2022

Celebrating a triumphant year

By Kendra Worthington | BMES Representative

*The Bioengineering Day 2022 planning committee and volunteers. Seated in the front are co-chairs **Arnav Tayal (left) and Bernice Lozada (right).***

Excitement filled the air in the morning of April 22nd, 2022 as students, faculty, and community members alike began to fill the venue. Bioengineering Day 2022 was in person again for the first time in three years. The planning committee began their efforts in October 2021, and now they would see the fruits of their labor in the 16th annual occurrence of this day-long event.

The day started off with an inspiring keynote speech by Dr. Jay Rubinstein, Professor of Otolaryngology and Bioengineering at the University of Washington. Dr. Rubinstein's academic journey did not begin in bioengineering, but rather in electrical engineering and neuroscience. This background combined with his current work that intertwines medicine and engineering captures this year's theme of "Bridging the Boundaries in Bioengineering" and provides an excellent example of how bioengineering brings together many areas of expertise.

The most lively part of the day came next in the form of the first of two senior design poster sessions. Seniors stood around their posters, presenting their year-long projects to young undergraduate students as well as professional judges with many years in their fields. The chatter of scientific communication filled the room as the seniors impressed the guests with the results of their hard work. Indeed, the array of topics, from medical devices to tissue engineering to machine learning, harks back to the vast nature of the field of bioengineering which brings together so many disciplines under one research umbrella.

After the poster sessions came a networking lunch, where students had the opportunity to chat with professionals in both academia and industry. Events such as these are invaluable to students, as they can use them to make connections to launch their future careers while learning from the experiences of the incredible faculty

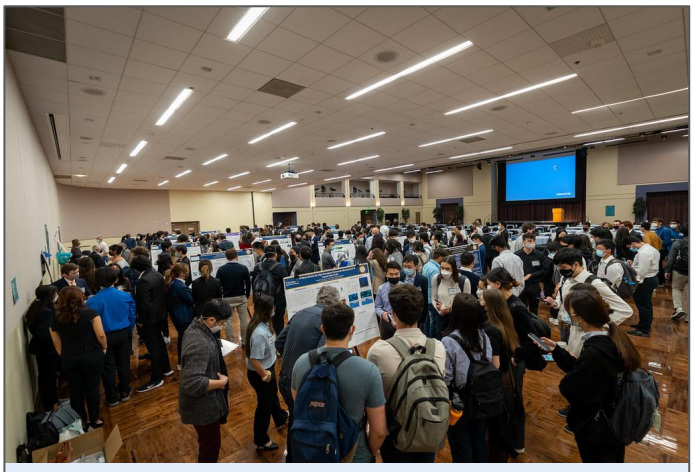
*Keynote Speaker, **Dr. Jay Rubinstein**, during his speech*

and industry representatives who graciously lend their time to interact with students at this event.

Lunch was not the only time that students had to learn about industry, as there were 3 companies presenting demonstrations in the early afternoon. Occurring at the same time as graduate student research talks, these demonstrations play an important role in allowing students to explore the possibilities of bioengineering beyond the UCSD campus.

The excitement of the afternoon poster session equalled the thrill of the morning one, as the other half of the senior design teams presented their research. However, this poster session featured some special guests: a senior design team from Purdue University! These four students flew all the way from Indiana and were representatives of a year-long collaboration the UC San Diego BMES chapter has with the Purdue BMES chapter. Not only was Bioengineering Day bridging the boundaries of bioengineering research, but also bridging the boundaries of state lines to bring us the first ever collaboration of this kind.

Concluding the event was the annual Quizbowl Tournament, a trivia-style competition. The final game of the tournament is played between the top undergraduate team and a graduate student team. This year, the winning undergraduate team were all 1st year students. Stacked against a graduate student team with more years of college experience, the odds seemed against the younger team. Their youth did not mean a lack of expertise, however, as they outperformed the graduate students to win the final round!



The room was full during the poster sessions! Students and professionals of all ages joined to talk about the exciting results of the senior design projects.

As one of BMES's last major events of the year, Bioengineering Day shines as a time to celebrate the accomplishments of the San Diego bioengineering community. Furthermore, the event ties into the UCSD BMES mission of being a resource for all students interested in bioengineering, as all students and professionals regardless of their major or background are invited to attend the event. Year after year, Bioengineering Day is a resource for a community of excited individuals who share a passion for bioengineering, and we hope to see you at Bioengineering Day 2023!

Interviews with Professors

Bauerngarten, by Gustav Klimt (1907)

Shadi Dayeh, PhD

Transparent Advances in Neurotechnology

By Meenakshi Singhal | Editor-in-Chief

Dr. Shadi Dayeh, PhD is a Professor in the ECE Department at UCSD. As the Principal Investigator of the Integrated Electronics and Biointerfaces Laboratory, Dr. Dayeh leads a forward-thinking team working towards improving the precision and versatility of brain mapping technologies. His lab's most recent work synergizes advances in materials science with clinical perspectives to transform the nature of monitoring during neurosurgery.

Q: Could you give an overview of your research journey and how your interests have evolved over time?

I majored in physics during my undergraduate studies and was always interested in understanding how things work. The topics in the physics classes were really a reiteration of my work experiences and life observations and how we can shape matter to behave in different ways. In the later stages of my college degree, I became interested in electronics and came to the U.S. to complete graduate degrees in electrical engineering. In my Masters degree, I started working with free-standing infrared sensors on flexible substrates manufactured through what's called micro-electromechanical systems (MEMS) processes. During my PhD thesis work, I investigated very small transistor materials—high mobility materials to make things more computationally powerful and compact. Towards the end of my PhD, I picked up a book about how the brain works. The currency of communication in the brain is ionic currents, the equivalent to electrons in electronic devices and circuits, so I started to see synergy there.

The first conference I attended during my postdoc was an IEEE conference that had a symposium on emerging technologies. One of these emerging technologies that were covered was neural interfaces—*the topic of how can we marry matter with biological tissue?* Speakers presented the different types of interfaces, and it became apparent to me that some of the structures I was working on at Los Alamos in 2008 seemed to be basically the sweet spot between what's called Faradaic and capacitive devices to interface with the brain. So, I came back to Los Alamos and presented

some preliminary ideas on this topic to my postdoc mentor, and he was supportive to pursuing research in this domain and connected me with more people who do biology at Los Alamos. We submitted an internal grant application at Los Alamos, and in late 2010, we got funded by a $1 million grant to carry out that work. A little over a year later, I got this faculty position here at UC San Diego in November 2012 and the BRAIN® Initiative was announced shortly after. At UCSD we have a really outstanding and effective ecosystem for bringing multidisciplinary research to fruition. The campus arranged for meetings between engineering faculty, neuroscience faculty, as well as clinicians from the Medical School. During those meetings, we started to refine how we want to address interfaces of biological tissue based on input from clinicians. So, this is the journey that took me from physics to now work on neural interfaces. Still about one third of my lab does high-speed transistors, but most of the sensors that my lab is creating are geared towards interfacing with biological tissue.

Q: How have advances in materials science been part of the research story?

I think part of the interest and the trajectory there is that during my upbringing, I was developing as an experimentalist: I worked in a car mechanic repair shop throughout early middle school to high school and that's where physics became a favorite topic at school. There are instances in my graduate degree where I was challenged in terms of, *how deeply do I really understand things?* And to be able to answer those questions, one has to go back to the fundamental building blocks of matter, which is science at the atomic scale. *How can we build materials and understand how their structure affects their performance?* So that really fascinated me in part during my PhD. After a few years and reading many hundreds of papers, I was able to explain how certain types of materials grow. At Los Alamos and during my postdoctoral studies, I got involved in a different material system, where at the time, building pure material combinations with that system was very hard. So, I spent a large proportion of my research time investigating with transmission electron microscopy how atoms arrange in a particular manner at the individual atomic level for the different material growth conditions that I used in my experiments, two years of which, were dedicated to studying defects on semiconductors. For defects, surface and interface energies are critical, particularly in a nanoscale system, and generally for any type of engineering problem. If we consider electrochemistry, one interfaces biological tissue with electrochemical reactions that occur at that interface—how the atoms are arranged at the interface, *in fact matters*. It determines what's the level of the chemical potential at the surface. That electrochemical potential determines how we can exchange electrical charges between matter and the solution. So even though these disciplines may appear too far from each other, they are actually sisters—they're closely related.

Q: The neurotechnologies that your lab develops create unique opportunities for clinical experimentation. How does collaborating with physicians and surgeons shape your lab's work?

Interactions with physicians had a huge influence on our work and really shaped it in a way that we have to do things more robustly right now and there needs to be a lot of validation and verification. Considering that the devices made in the lab are going to be implanted in a person, that means that every little step has to be carefully planned. To the maximum extent, we all do our best to participate in being careful. On the other hand, one must acknowledge that there can definitely be some kind of mismatch in terms of the language that the clinical and the engineering communities speak. It takes some time to cross that barrier, but there are more common grounds than differences, especially that both communities are heavily interested in solving problems that matter: helping advance 1) science and 2) medical care for the patient in the field of neural interfaces.

In this open interaction, we do our best to listen to the *statement of needs* provided by the clinicians. Simultaneously, our clinical colleagues listen to our capabilities with the technology, and then tell us if the things we propose could be useful and could help them treat patients better. One advantage here at UCSD is the ease of communication between the two disciplines; another one is that we have neurosurgery residents with an engineering background. One resident who had a computer science undergraduate degree had joined my lab early on in 2015; it was a perfect fit for us to work together and understand each other very well, and to move this work to the next level. For any of us, *we should not be limited by our circumstances*, in this case the technical training that defined our expertise, and be open to always take practical steps to follow our imagination in where we expand next.

Q: What scientific questions could be asked and answered with the brain mapping tools that your lab develops? In particular, how do you envision these high precision arrays becoming part of standard clinical practice?

Fundamentally, we are trying to determine what are the smallest computational units in the brain that we can measure from the surface. We started to get a glimpse of that—right now, we are measuring functional cortical columns. This is the granular size of the cortical layers that are associated with a particular phoneme, for example, or a particular finger movement. Thus, the goals are 1) to understand how action is coordinated in the brain and 2) understand that action not only spatially, but also spatiotemporally. With the grids, we are now able to measure brain waves. So we can look at patterns of brain activity to decode a particular aspect of what we intend to think or say, as opposed to just measuring potentials in a specific context. Beyond the fundamental science aspect, we want to aid neurosurgeons in localizing boundaries for function and disease. Traditionally, clinical electrodes

The three co-first authors and senior author on the Science Translational Medicine paper that reported recording the human brain activity in record breaking resolution. ***L-R: Daniel R. Cleary, Andrew M. Bourhis, Shadi A. Dayeh and Youngbin Tchoe.***

for mapping the surface of the brain have an inter-contact spacing of about a centimeter. If the surgeon is looking at a region of the brain that has motor function, they keep a margin of about 5 mm in between the contacts. If it's language, it's about 9 mm-10 mm. These are huge chunks of the brain that could either be diseased or eloquent.

Now with the millimeter or sub-millimeter scale grids that we have developed, we can look at the curvilinear boundaries of function, of tumors, of epilepsy, and guide the surgeon to do the resection very precisely. Even in cases with an implant—like a pacemaker that needs to be put for a patient with epilepsy—this pacemaker no longer needs to pump amperes of current to stimulate the global tissue. Instead, as we move towards sub-millimeter resolution, we can map exactly where the epileptic discharge originates and deliver a smaller amount of charge exactly right there, and thus reduce the side effects that accompany large stimulation currents. In existing clinical practice, seizures do cease with electrical stimulation, but there are often side effects that happen, like ringing in the ears or twitching in the cheek, etc. More localized stimulation is expected to reduce if not eliminate these side effects.

Another modification is my DP2 Award (NIH Director's New Innovator Award) in which we will integrate light-emitting diodes (LEDs) onto the grids so that the surgeon will be able to see directly from the surface of the brain. There will be no need to wait for information to come from the electrophysiologists in the back of the room, and to tell them, *contact 3 and 16*, for example are associated with memory (to avoid resection within 10mm from these contacts). The surgeons will instead be able to see directly the relevant eloquent tissue (green LEDs) and diseased tissue (red LEDs) in front of them on the surface of the brain, and plan the resection by relating the grid location with the underlying anatomy because these grids are transparent.

So that's what we are preparing right now, and then the second term objective is that these arrays are all single-time use during the operation. But then there is monitoring that needs to be done for up to 30 days—it's called semi-chronic monitoring. And this relates to patients with epilepsy, whose epilepsy is not focal, and is oftentimes below or under the surface of the brain. These patients need to be monitored in the epilepsy monitoring unit (EMU), and often there are a lot of wires that externalize out of the head
of the patient for that duration.

Therefore, our goal is make this procedure completely wireless, while increasing the spatial resolution of the mapping. This approach will reduce the burden on the patient, will reduce the risk of infection—in terms of the wireless aspect—and maybe one day, the patient doesn't need to sit down in the EMU. They can go home, and they will still be monitored all the time.

And another level after that is to use these devices for brain-machine interfaces (BMIs); that would be the chronic application, in other areas like Parkinson's disease, where a permanent implant needs to be present. The challenge there is to make sure this will work properly for a long duration of time and have minimal effect on the tissue. This is what we're aiming to accomplish in the next few years.

Q: I recently read an interesting paper about speech reconstruction, and the way they were doing it is through electrocorticography (ECoG), so taking measurements directly from the brains of epilepsy patients during neurosurgery. The researchers then put this information into a neural network to reconstruct speech. Do you think the array systems that your lab is creating can be used with that kind of clinical application in mind?

I think the arrays we are developing will take that kind of work to the next level. I believe the paper you were talking about may have been from Prof. Edward Chang's lab at UCSF. What they've done was to measure the neural correlates of speech, and to link that to the kinematics of mouth movement. Subsequently, the neural correlates from the brain on their own were used to decode the sentences that the patient intended to say without moving their mouth. The grid used in that study is a custom-made grid: it has 4 millimeter-spaced contacts, with 256 channels. In that same area, we will have 4,096 channels, with 1 millimeter spacing. In a separate study, we determined that speech correlates to specific phonemes can extend about a millimeter on the surface of the brain. To this end, we are currently creating maps of the specific phonemes that are decoded from the surface of the brain in individual patients using our technologies. I can imagine that if it's applied for decoding speech, that this will be the most powerful platform to provide a high-fidelity speech prosthesis.

Q: So for the process, it would first be carrying out some kind of animal work before directly taking it to humans?

Indeed, to be able to implant these grids for the duration of epilepsy monitoring, which is up to say 30 days, to replicate the experiments that Eddie did but with a more precise and energy efficient implant, we are funded by the NIH to develop this platform as a semi-chronic and wireless platform. In the pathway to get approval from the FDA to do such experiments, we need to show that the device is effective in what it does—and we need to do that in a large animal model, like pigs for example or sheep. These are our planned experiments about two years down the line from today. Once we validate safety and efficacy in large animals and combine with our

benchtop and biocompatibility, sterilization, packaging, and shelf lifetime tests, we can send the information to the FDA, in the hopes that we can get clearance for a small clinical trial for epilepsy monitoring. This development will enable many other trials with this technology.

Q: At the university level, what steps do you think can be taken to advance or facilitate the so-called *bench-to-bedside* approach, or research endeavors in translational medicine?

I think, in addition to basic science and clinical perspectives, you also need engineering, so the medical technologies. Here at UCSD, we have institutes that promote clinical translation, like the Altman Institute for Clinical Translation (ACTRI). What we really need more of is funding for new ideas, so that more people can apply resources towards their labs, and there can be more symposia to bring scientists and students together to talk about problems that matter. Creating venues for all of these people to listen to each other is important, because all of us get so ingrained in our own research, and our own ideas of how to solve problems. It is really important to take a step back and have a broader perspective of how things are done, and listen to the relevant needs. For example, my area is in medical device engineering: we listen to the *needs of the clinician, the arguments of the scientists*, and then try to come up with engineering solutions that will use fundamental science in order to address important clinical needs.

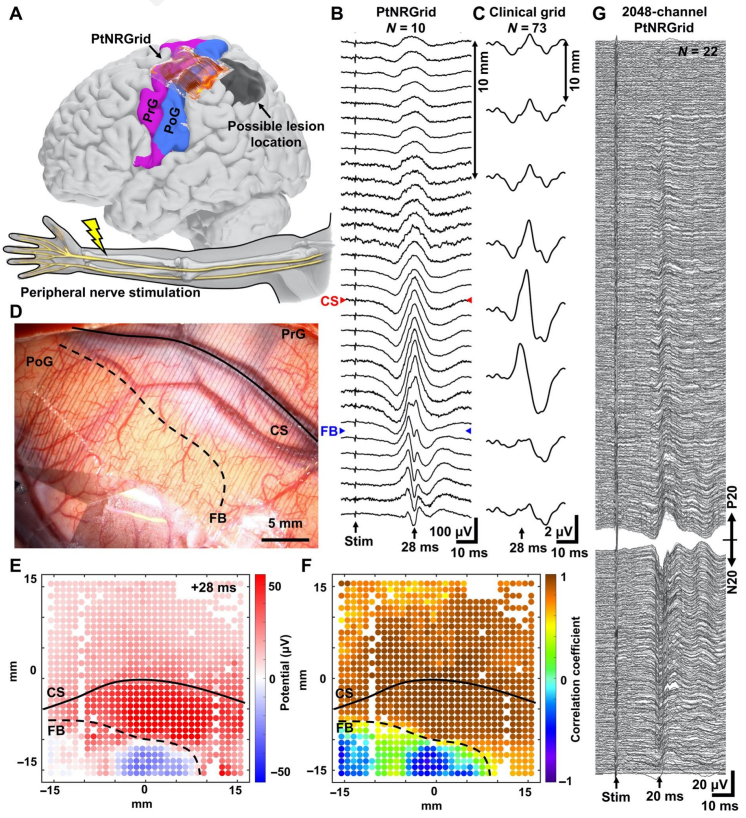


Fig. 2. Mapping the curvilinear nature of the functional sensory/motor regions in the human brain with millimeter resolution.
(A) *Reconstructed model of the patient's brain and electrode implantation locations. Electrodes were implanted near the hand region, and the peripheral nerve was electrically stimulated. Somatosensory evoked potential (SSEP) waveforms along a line across the central sulcus (CS) and M1-S1 functional boundary (FB) recorded with* ***(B)*** *32×32 PtNRGrid with 1 mm spacing and* ***(C)*** *2×8 clinical grid with 10 mm spacing.* ***(D)*** *Implantation photos of the electrodes near the hand region.* ***(E)*** *1024-channels potential mapping of the stim-evoked waves 28 ms after the stimulation* ***(F)*** *Correlation coefficient mapping with respect to the waveforms measured with respect to the channel in the center of the grid.* ***(G)*** *Human brain SSEPs from 2048 channel PtNRGrid. Channels are sorted according to the peak potential amplitude and polarity at 20 ms after the stimulation, and channels with high contact impedance were excluded from the plot.*
Source: Science Translational Medicine 14, eabj1441, 2022.

Q: Do you have any advice for students at the undergraduate level interested in pursuing graduate school in neural interfaces or medical device design?

What I would say is that we always need to be open to a lot of the information that we receive, and examine it. *Be aware of what's happening.* But the most critical thing that you could do at that career level is to dive as deep as you can in one fundamental aspect of the research that you are doing, and be able to show that you've done something unique—that you understand it so well that you are the world expert in it. Once you do that once, then that means you can do it twice and three times and four times later. But don't imagine that you can right away solve the problem of neural interfaces in a PhD project, because that means you are touching too many areas just on the surface. And it really needs big teams, not an individual lab—not even an individual discipline—to solve these types of problems. So I think understanding and framing the challenges in the proper context is quite important. And equally important is that one really needs to focus on an individual problem—one very big problem—and be super good at it. And there are a variety of resources within grad school; there are resources at the departmental level, school-wide, and also at conferences and society-wide, that I'd advise students to look into. Not to become fully distracted but to be involved and learn and explore opportunities. And the broader you get involved during grad school, of course the larger your network is, though one must be careful not to compromise the depth that I discussed earlier, because that's what will carry you forward. Networks will help, but if everything goes away, then your experience will always remain with you throughout time. That's what you should always be working to strengthen very well and all the time.

And also take time to learn other things, so that you develop a unique way of looking at things; so don't be overfocused, but be able to come out of the bubble of the research problem you are working on and think about it in a different perspective. I think I should mention that one of the most critical things is to really read papers in depth; every day, when you start in a new field, you basically want to read all the papers that have been written. For this, in the first few weeks or months, this literature review will take a lot of time. But once you understand the ins and outs of your topic, you'll find a lot of repetition in papers, so then the papers will take less time to read. And the more you read, the broader your understanding and the richer is the toolset that you will use in your research. And that's incredibly important at the beginning, so take time to read, before you go on and try things in the lab.

Ester Kwon, PhD

Nanomaterials to Sense the Brain

By Nicholas Sada | Spotlight Writer

Dr. Ester Kwon, PhD is an Assistant Professor in the Bioengineering Department at UCSD. Her lab generates elegant engineering solutions at the intersection of neurobiology, nanomaterials, and pharmacology. In this interview, Dr. Kwon shares her insights on engineering for the brain, translational medicine, and mentorship in research.

Q: What has your academic and professional trajectory been like? How has this affected your choice of research?

I think it's a little bit of a two-way street. Sometimes I chose training experiences because of what I wanted to work on for my research focus and sometimes training experiences have informed my choice in research focus.

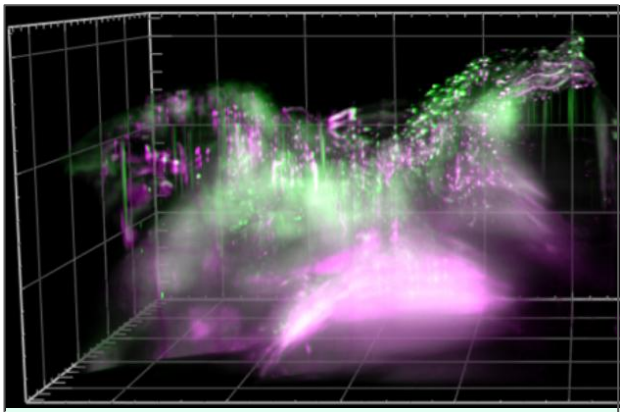
I have my bachelor's in bioengineering but also in molecular and cell biology from UC Berkeley. There, I did biophysics research in single molecule unfolding. At the time, I really wanted to do more applied research because I wanted to do things that could impact human lives. I did an internship at BioRad as an undergraduate and my responsibilities there as a bachelor's made me want to elevate my degree of involvement in the research, so I decided to go to graduate school. I did my PhD at the University of Washington in bioengineering with Suzie Pun where I worked on non-viral gene therapy, specifically, on modifying nanoparticles with peptides to give them biological activity. My intention was still to go to industry and to work in a company so I did an internship when I was in graduate school at Seattle Genetics, which is the company that made the first antibody-drug conjugate. I had a valuable experience there but *I think the aspect that I really enjoyed about academic research was mentoring students.*

I had the opportunity to mentor many junior PhD and undergraduate students so I decided that a faculty job would be a good fit for my interests. My experience during my PhD was to build nanoparticles for the brain and there is a lack of understanding on engineering responsive materials that could integrate with the host. Therefore, I decided to do a postdoc in pure neurobiology because I wanted to understand the biological system before engineering on top of it. I did a

postdoc in neuroscience where I studied mental illnesses and their genetic causes and learned quite a bit. Then I did another postdoc at MIT knowing that I wanted to develop materials that could really respond *not just to a cell or a protein but to a whole organism.* I worked on a number of different types of nanoparticles and investigated how they could be used as diagnostics or therapeutics in multiple types of disease models including traumatic brain injury, cancer, and lung infection. That brings me to my lab today here at UC San Diego. Our goal is to develop nanomaterials – materials that have dimensions on the nanometer length scale – as tools, diagnostics, and therapeutics to treat disorders that affect the brain. My lab's goal is to engineer materials that integrate with biology. One of the things I think is cool is that sometimes when we engineer new materials and put them in the body, we create new, emergent biology. The convergence of biology and engineering is an exciting place for the future.

Q: I saw on your lab page that you do a lot of nanomedicine work in therapeutics, especially related to traumatic brain injury. Would you say TBI specifically is the focus of your laboratory or can you give us a general overview of what research you're focusing on right now?

Currently, our lab works on developing nanomedicines to treat traumatic brain injury; that's because it affects millions of Americans every year, yet there are no therapeutics that can a patient's quality of life in the long term. There have been advances in emergency medicine where the focus is on sustaining the patient's life at the time of trauma, *but 50% of patients will have some sort of lifelong impairment in cognition, motor skills, or psychosocial behavior.* There are no treatments that are known to prevent these long-term impairments. I've identified this as an unmet need that engineering could help solve in traumatic brain injury. Another note is that we know that people who get brain injury are more likely to get early onset Alzheimer's disease even from a single event which becomes more common with repeated head injuries. We know that there's cellular degeneration so we think that in the future, the scope of our research can be more broadly applicable to neurodegeneration.



3D brain image of traumatic brain injury sensor.

The technologies that are under investigation in our lab can be sorted into two categories. One is molecular diagnostics. After injuries, there are a lot of different molecular pathways that are occurring and we know that therapeutics work on specific molecular pathways so we want to close

the loop between these two. One thing that we're doing is trying to measure a specific molecule called a *protease*. These proteases cut other proteins and there's one protease called calpain-1 that cuts many different proteins in the brain. The activity of this protease elevates significantly after traumatic brain injury. Furthermore, calpain-1 is also a target of therapeutics and *we think that by measuring its activity – not just the presence of the protein but also its ability to cut – would be very valuable to understand the disease process.* Also, if we can measure it, it could potentially be a way to diagnose disease and identify therapeutics that a patient could receive. We built a nanomaterial that is responsive to protease activity and this activity is different than just the presence of the protein because it can be affected by its environment. For example, the pH of an environment, the concentration of cofactors, and localization–whether it's inside a cell, outside a cell, or in a subcellular compartment–are all factors that affect a protease's activity. It's difficult to capture when taking the material out of the brain so we want to capture it there. We built a polymer-based nanomaterial that has a sensor for calpain activity which lights up when it encounters a calpain protease, letting us image protease activity in a living brain for the first time.

The second category of technologies that our lab is interested in is therapeutics for the brain. In particular, nanomaterials are good for the delivery of hard-to-deliver cargo. This includes things like proteins and nucleic acids which are difficult to deliver because they're large and can be degraded in the body. *Nanomaterials can protect them and help them get into different types of cells.* Here, a particular material that we've been excited about is focused on the delivery of nucleic acid cargo such as siRNA and mRNA. We're really interested in making materials that can target specific cell types within the brain such as the neurons or endothelial cells, so we take the nucleic acid nanoparticles and deliver them to different cell types in the brain to help regeneration after TBI by giving them cargo to help neurons survive, helping neurons proliferate, and potentially restore different functions of the brain like the blood-brain barrier.

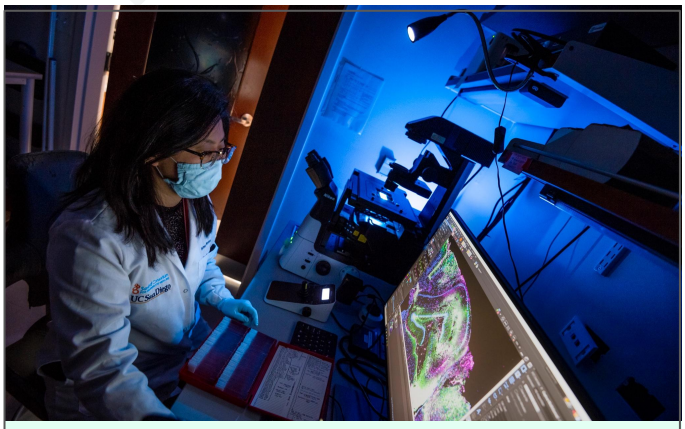
Q: I read an article recently that covered some of your work and it mentioned that the blood-brain barrier is one of those things that you need to deal with when working with the Central Nervous System. Would you say that's one of the main unique challenges when working with this system or are there other factors that are in play here?

The blood-brain barrier (BBB) is an issue for drug delivery in healthy, intact brains. In traumatic brain injury, we can exploit the fact that the blood vessels are injured and we can get material across that broken vasculature. It's only for a short period of time though, so we can only do so within a limited time window. Another problem that we think of a lot is that *the brain is a really sensitive organ with a lot of different cell types.* So, getting material into different specific cell types

is an important challenge to overcome. There are neurons, microglia, and astrocytes, and you can imagine a drug would affect those different cell types very differently, so the key to limiting toxicity–which is the reason most drugs fail in the clinic–is to reduce the activity of the drug in off target areas. A big interest we have in our lab is to target our materials to specific cell types within the brain in order to increase the specific action of our therapeutics.

Q: I saw in the same article that you're working with trying to diagnose TBI from blood and urine samples. I was wondering if that plays at all into translational medicine and the *bench-to-bedside* approach and what your opinion is on translational medicine as a field?

We have redesigned the calpain diagnostic I was talking about where you can look at protease activity in the living brain, so that we can measure that same signal as a urine signal instead of as a fluorescent signal in the brain. That's exciting to us because if you get a brain injury, the best thing you can do is get to a trauma center to get quick treatment, and you need to do that within hours. However, most people will never go to the trauma center. Something that can make a big impact is quickly diagnosing in the field then getting people to a trauma center, so that's one interest we have. Now that we've proved our sensor activates in the brain, we can now make it detectable as a small fragment in the urine instead. In fact, multiple senior design teams in my lab have worked on trying to develop this sensor as an actual medical diagnostic for translation instead



Imaging traumatic brain injury sensors in the brain.

of just as a tool. I think that the field of translational medicine is really important. Our research can help other people and impact human lives. There are many examples where some of the basic knowledge that we generate in academic labs can make an impact on providing medicines, diagnostics, and knowledge for society as a whole.

Q: I saw that you were awarded the 2018 NIH Director's New Innovator award and later the 2021 NSF Career Award for work with traumatic brain injury. What was your experience working towards these awards and do you have any advice for students who may in the future want to do something similar?

I think the basis for those awards is having an idea that you have a lot of interest in and are passionate about. I think those two factors are the main ingredients for creating a compelling research proposal that is also likely to work: having a lot of interest in a

particular area and then working on that, sometimes with a lot of failures. *Oftentimes, you see the awards and successes of faculty members but you don't see the multitude of failures that we also experience which are just a natural part of doing research and being an engineer.* Part of it is just being determined to continue working on what you're interested in, taking feedback and readjusting your course when necessary but also having your own north star to focus on.

Q: I know you talked earlier about how mentoring was a big part of your trajectory and I saw on your website that you're very focused on making the research environment more inclusive which I think is very important for strengthening the field of Bioengineering overall. How do you think that we can promote an inclusive research environment and how do you think this can contribute to the field of Bioengineering overall?

I strongly believe that we all have something to contribute to engineering and that every person has potential. That's why I think it's important that everyone feels they're welcome to make contributions as long as they have motivation. From my point of view and in my role, I develop training plans for each individual student that I come in contact with in my research lab or in my classroom. That means identifying the goals of each student or trainee, what they want to accomplish, and what's important for them, and then designing training plans with activities, projects, and collaborators based around what the student is interested in doing or accomplishing. I think those goals really need to align to bring the best out in each individual and there's also opportunity for me–as someone who's maybe had more experience–to identify opportunities or training activities. Part of my role is to advocate for the trainee: identifying opportunities they may not be aware of but also potential room for growth in certain areas. All of this is based on identifying for each person what they need and what trajectory they would like to go on and then developing a plan around that.

Q: What do you think about Bioengineering as a field and how do you think it will evolve over time?

I think in general there is a convergence of biology and engineering for the field of Bioengineering, so instead of thinking of them as two separate fields that are interdisciplinary, there will be a convergence; you won't be able to see the seams between the two disciplines anymore. I think that's where we're going, knowing that every time we engineer something that interfaces with biology, we change the biology and that changes our engineering.

Q: Going back to the mentorship aspect, do you have any general advice you'd like to impart to the students?

I think in general, what I would recommend is that a lot of us Bioengineers have a lot of different interests so sometimes it's difficult to choose, but *I would recommend really honing your interests in a specific area and really going all in to developing your passion and expertise in that area.* You can always come up for air and change directions so don't feel like you're going to have to stick with that forever. Don't be afraid to try things but also try them with a lot of passion and dedication. It's really difficult to make headway if you try a lot of things at a lower effort. Also, there are always mentors around you who want to help you do your best, so ask for advice. There are lot of people who want to help you, sometimes it's just a matter of reaching out and asking for help.

Pedro Cabrales, PhD

Human Physiology in Flux

By Romina Shirazi | Deputy Editor-in-Chief

Dr. Pedro Cabrales, PhD, is a Professor of Bioengineering at UCSD. He is the Principal Investigator of the Functional Cardiovascular Engineering Laboratory, which focuses on applying multiscale approaches to understand fundamental cellular processes related to homeostasis and hemodynamics. In this interview, we learn more about how Dr. Cabrales' experiences as both a scientist and an educator shape his perspectives.

Q: What is your educational background, and how did you join the Bioengineering Department?

I graduated from the University of Los Andes in Bogota, Colombia; I was interested in Mechanical and Electrical Engineering. I chose the Bioengineering path for my graduate studies because the projects I was working on during my Master's and Ph.D. programs had a heavy biological component. These projects drove my curiosity to learn more about biology and physiology.

Q: What were the projects that you worked on as a student and inspired you to learn more about Biology?

My first project was on computational modeling of abdominal aortic aneurysms (AAA) of patients scheduled to receive AAA repair surgery. We made morphological reconstructions from the patient's images and computational models of the blood flow inside the AAA. We calculated the stress and strain distributions on their aneurysms with the fluid models. And after the surgery, we measured the mechanical properties of the AAA removed during the repair surgery to obtain properties such as Young's modulus and the rupture stress. These parameters were later compared with the stress and strain distribution to define the risk of rupture for that specific patient, even though they had already received the repair surgery. Since AAA repair surgeries are very risky, ideally, we wanted to know the risk of rupture. During my master's, we implemented this test in nine patients, partly because computers back then were extremely slow relative to now. I can only imagine what can be done with the computers available

nowadays. Before this, during my undergrad, I worked on a mass transport model to optimize the dialysis time of patients. Hemodialysis is a treatment that removes metabolic waste and water from the blood in people with acute or chronic kidney failure. At that time, the hemodialysis time was defined based on the difference between the patient's weight at the beginning of the session and the predefined dry weight for the same patient. Basically, the hemodialysis time was calculated as the time required to remove the excess water without considering the other metabolites that needed to be removed during the procedure. We developed a model based on bilirubin clearance to define the optimal time for dialysis. Bilirubin is a yellowish metabolite, which in part gives the yellow color to urine and is produced from the degradation of hemoglobin. The hemoglobin from red blood cells is constantly destroyed as red cells complete their life cycle, and a set amount of bilirubin is produced daily. Bilirubin is usually excreted by the kidneys. The project ended by defining a color metric to measure bilirubin in the dialysis fluid, and when bilirubin was mainly removed from the dialysis fluid, the hemodialysis could stop then. The proposed solution allowed for optimization of hemodialysis session time.

When I started my Ph.D. project, Colombia was almost in a civil war. The government created a program that supported making artificial blood as many people were dying due to bleeding and lack of blood availability. And keep in mind that Colombia is mostly a jungle, and there is no easy access to electricity or refrigeration. So, we had to come up with something that could be used in the hot and unfriendly battlefield environment. Blood was not practical there; thus, we had the idea of making a fully synthetic oxygen carrier, which was a very ambitious idea at the time. We successfully created a clean facility and made an emulsion that was able to dissolve and transport 20 times more oxygen than water. We were able to replace blood with this emulsion in rats and confirmed that it transported oxygen to tissues and supported life. However, one of the limitations of the oxygen-carrying emulsion was that it only dissolved oxygen proportional to the oxygen concentration in the lungs.

Consequently, the oxygen-carrying capacity was limited by the partial pressure of oxygen. This made things challenging since our studies were completed in Bogota at nearly 3000 meters over sea level. At the same time, a San Diego company called Alliance Pharmaceuticals was developing a very similar perfluorocarbon-based oxygen-carrying emulsion. They appeared to have more promising results when evaluating the perfluorocarbon emulsion at sea level. After reviewing their results, we figured that *due to the altitude and the reduced oxygen partial pressure in Bogota, we needed to increase the percentage of oxygen to compensate for the lower partial pressure.* I came to UCSD from Colombia to continue working on this perfluorocarbon-based oxygen-carrying emulsion. Specifically, I wanted to study what happens in microcirculation when perfluorocarbon emulsions are in circulation and how they transport and deliver oxygen to tissues.

Q: Could you share some of the research projects that your lab is working on?

The lab has different research areas, but most of them are related to the cardiovascular system and the microcirculation. We have a lot of emphasis on blood, the effect of blood transfusions, and trying to develop alternatives to blood. We want to make alternatives to blood capable of supplying many of the different functions that blood has. Blood transports oxygen and nutrients, and supports hemostasis (the coagulation system) and the immune system. Another research that we are currently working on is understanding the implication of a blood transfusion. Blood is living tissue with an expiration date, since blood cells do not circulate for more than 120 days; thus, a blood transfusion is like an organ transplant. Blood is an organ that flows through and interacts with every tissue and organ of our body. Understanding the effects of a natural blood transfusion has helped us develop better approaches to creating artificial blood and improving its compatibility.

Q: Were there any life events that you were inspired by to start a research project?

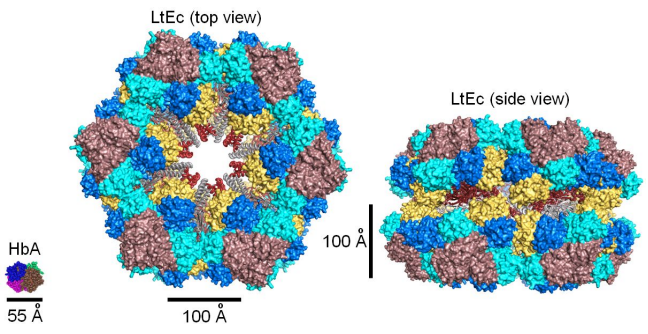
Life has always presented me with different situations that have inspired me to develop new research areas in the lab. For instance, I started working on the cerebral hemodynamic implications of traumatic brain injury (TBI) because my wife suffered a TBI by hitting her head on the kitchen door, which increased her seizure frequency. She ended up receiving brain surgery two years ago to remove the area of her brain, triggering the seizures. *It was incredible to see how the brain's cardiovascular and nervous systems are interconnected.* Nowadays, she is doing much better. We have developed several projects in the lab to develop therapies to improve the outcome from TBI, currently supported by the Department of Defense.

Q: What are you long term goals as a professor at UCSD?

I always try to become a better teacher and inspire my students to think about the class topics. It's not about how much you teach, it's about how much of the material stays with the students after the class is over. I find motivation and passion as crucial factors in supporting the learning experience; they keep us going without giving up and promote curiosity to keep asking questions.

Q: What are some of the important skills that you think bioengineers should possess?

Common sense and logic, and applying your knowledge to your everyday life and problems. Being able to find a way to apply what is taught in the classroom. Sometimes as professors, we don't make a big effort to explain how the teaching material can be applied to practical problems. However, *the learning process is significantly more fun and rewarding when you can make valuable practical connections between the theory and the practice.*



PEGylated mega-hemoglobin as a red blood cell substitute (pcabrales.eng.ucsd.edu)

Q: As an educator, what do you think is the purpose of higher education? Is it merely an economic signal for employers to sort out highly-skilled laborers?

The purpose of higher education is to further expand people's skills. The joy and the satisfaction that people get after learning and applying new skills to topics they are interested in is the best way to promote learning.

Q: It seems that students sometimes have difficulties transitioning from academia to industry. Are there any plans to bridge this gap within the department, perhaps through more interactions with biomedical industries?

Bioengineering is being taught more theoretical than practical now, and it is challenging for the students to know how to apply the equations, concepts, and knowledge to specific situations. But the department is working on having more interaction with the local companies and industries to support student internships and facilitate the transition to industry and support the needs of the local biotech community. The priorities of academia are very different from the priorities of the industries. These internships are an excellent opportunity for students to learn the language that the companies want to hear and to apply what they have learned.

Q: What do you think is the next "big thing" in the field of bioengineering?

Bioengineering is being recognized more and more every day, but one of the big things growing very quickly is personalized medicine. In the past, medical doctors always followed the same recipe/procedure for all the patients, but this method does not necessarily work for everyone. *Finding the root cause of a specific problem for a particular individual could take many years, but with the help of more detailed and personalized tests, the doctor now can get to a diagnosis much faster and treat the cause of the problem and not only the symptoms.* One of the biggest challenges for bioengineering now is to help reduce the cost and increase the accessibility of personalized medicine. Thus, everyone will get access to rapid and complete diagnostic tests, not only the people who have more resources.

Physician Perspectives

The Great Wave off Kanagawa, by Hokusai (c. 1830-32)

Nikdokht Farid, MD

By Meenakshi Singhal | Editor-in-Chief

Envisioning the Potential of Neuroimaging

Dr. Nikdokht (Niky) Farid, MD, is an Associate Professor of Radiology at UCSD Health. As a board-certified Neuroradiologist, Dr. Farid diagnoses a variety of conditions, ranging from neurodegenerative disorders to tumors. Dr. Farid is the Associate Director of Neuroimaging at the Center for Translational Imaging and Precision Medicine; in this edition of *Physician Perspectives*, we learn more about her research towards advancing translational medicine and the importance of radiology education.

Q: Could you share your career path as a diagnostic radiologist, and how you became involved in the subspecialty area of neuroradiology?

If I trace it back to my undergraduate career, my major was Neuroscience. Even at that time, I had a keen interest in how the brain works—how the central nervous system and the peripheral nervous system result in not only movement and speech, but also higher level functions like thought and memory. However my initial plan was to pursue a PhD in Neuroscience. It was probably midway through my undergraduate years that I decided to pivot and go towards Medicine. There were different factors involved: my sister was already pursuing a path in medicine so she encouraged me. Moreover, although I enjoyed research, what excited me about Medicine was having a direct and positive effect on patients' lives. When I started medical school, my initial thought was to pursue a residency in Neurology. But about halfway through my medical school years, someone mentioned to me that I should consider Radiology. I had never previously considered Radiology. My research was in autism, and my faculty mentor was a Neurologist. But I decided to do a couple of electives in Radiology, after which I realized that Radiology is fascinating and that I really enjoy it. First, I directly observed that radiologists see all of the most interesting cases in the hospital. Second I noticed that the interpretation provided by the radiologist is pivotal in directing the clinical service in how to manage and treat the patient. Additionally, I realized that Radiology is at the cutting edge of medicine because it is such a technical field and is continually evolving. For those reasons, I decided to pivot again and pursue a Radiology residency. Following residency, I came full circle back to my love of Neuroscience and decided to do a fellowship in Neuroradiology.

Q: Could you describe some of your current research projects?

My passion is in translational research, where I take something that has been developed, such as a new MR sequence, and try to apply it to see if it can answer a specific clinical question. For example, in brain tumor imaging, there are many different imaging modalities and sequences we can use to image patients. One particular sequence that I have found to be very useful is ASL (arterial spin labeling) perfusion. We added this sequence to our brain imaging protocol about 7 years ago, and have found it to be an extremely helpful and useful sequence in various clinical scenarios. For example, when we look at a brain MRI of a patient with GBM (the highest grade primary brain tumor), and the patient has had prior surgery and chemotherapy and radiotherapy, the main question often is: "are the imaging findings post treatment change or recurrent tumor?" It can be tricky because the treatments these patients receive result in a lot of imaging findings which can look like recurrent tumor. In this scenario, ASL perfusion can be very helpful in distinguishing recurrent tumor from post-treatment change.

Q: Do your clinical and research practices guide or influence each other? How have your experiences as a practicing physician informed your research interests?

Absolutely. When I first joined the Faculty in the UCSD Department of Radiology, I was approached by a Neuro-oncologist. He said they needed a Neuroradiologist to commit to attend their weekly Neuro-Oncology tumor board every Friday. I was a junior attending and I was eager to create a niche for myself, so I readily agreed. It is through the connections and collaborations created at that tumor board—for which I am still the Neuroradiologist 12 years later—that I was able to figure out *what are the clinical questions in Neuro-Oncology and how can we use imaging to answer them*? What was created was a synergistic and fruitful relationship between my clinical work at the tumor board and my research. One of the things I love about academic radiology is the ability to interact closely with my clinical colleagues in Neurosurgery, Neuro-oncology, Radiation Oncology, and so on. This multidisciplinary team works together to deliver optimal patient care. The connections and collaborations formed at these multidisciplinary conferences result in advances in the field of medicine.

Q: What do you see as being the most innovative or crucial technologies currently being developed within neuroradiology that could translate to some kind of clinical benefit in the coming years?

Artificial intelligence (AI) is what is on everyone's mind, particularly in Radiology, especially in terms of how to increase accuracy and efficiency. Today there are so many AI tools and companies being developed. Ultimately, not every tool being developed

is going to be helpful—but a lot of work is going on in this field and I know that some of the tools will be very beneficial in increasing our accuracy and efficiency in Radiology. Of course, every tool that is developed will require rigorous study and validation. The overarching question is, *how can we incorporate machine learning and deep learning into our clinical workflow in seamless way?* I think it is very important that we as radiologists embrace these technologies. There is a great quote from a few years ago when AI first came onto the Radiology scene, and radiologists became scared that their jobs would go away. "*AI will not replace radiologists, but the radiologists who use AI will replace radiologists who don't*" (Dr. Curtis Langlotz, Radiologist at Stanford).

Q: How can students who are pursuing medicine learn more about the field of radiology? Are there ways to become familiar sooner in one's educational career?

In fact, I am on a committee that is working on updating the UCSD pre-clinical medical school curriculum. Dr. Sean Evans is leading the efforts to update the curriculum, and one goal is to incorporate imaging into the preclinical years, which are the first two years of medical school. Currently, you can only do electives in Radiology in the third and fourth years of medical school—and even those are optional. However, in the first two years of medical school there is currently essentially no exposure to Radiology. Imaging is such an integral part of how modern medicine is practiced that it is vital that medical students are exposed to radiology early on in their career—not only for those who may want to pursue a career in Radiology but also for those going into the many other fields of medicine (Internal Medicine, Surgery, Pediatrics, Neurology, etc.), as these future clinicians will need to know *what are all the different imaging modalities and studies out there and how can I use them to diagnose and treat my patients?*

Student Org Events

Farm Garden with Sunflowers, by Gustav Klimt (1913)

UBIC Chalk Talks

Connecting Students to Faculty Research

By Maddie Ritter and Kyra Fetter | UBIC Representatives

The **Undergraduate Bioinformatics Club (UBIC)** plans many events throughout the year, with one of its most consistent and exciting events being Chalk Talk. UCSD is a hub of innovative, ground-breaking research in bioinformatics—the discipline bridging data science, computer science, and biology. Chalk Talks introduce undergraduate students to the diverse research areas in bioinformatics first-hand, by providing students with the opportunity to interact with Principal Investigators (PIs) in an intimate small-group setting.

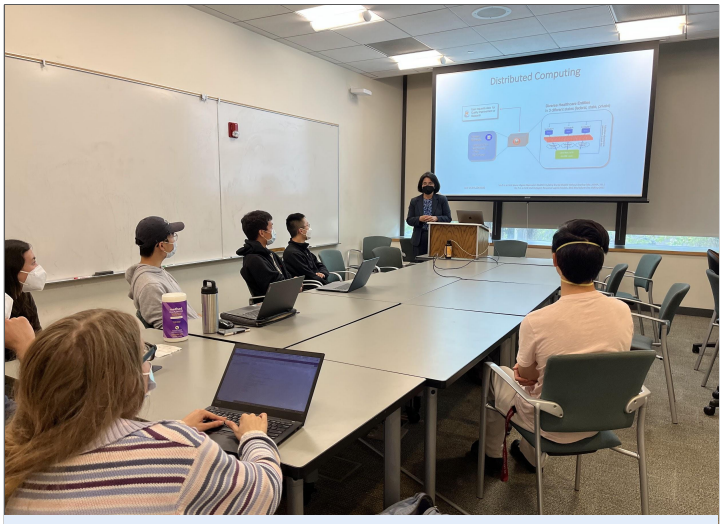
During each Chalk Talk, of which there are four to six each quarter, the professor gives an hour-long presentation, boiling down their research into simple terms; traditionally, they are equipped with only a chalkboard and a piece of chalk, as the name suggests. UBIC adapted this presentation format to virtual platforms with the onset of the COVID-19 pandemic; however, this past Spring quarter saw the first in-person Chalk Talks in over a year!

Chalk Talks are amazing opportunities for students to get to know faculty affiliated with UCSD biological studies—including professors from the UCSD Departments of Bioengineering and Data Science, the Schools of Biology and Medicine, and The Salk Institute in a more intimate setting. The small-group, conversational nature of these events are perfect for learning about a new line of research through a question-and-answer dialogue between students and the professor. Chalk Talks are also a great networking opportunity for those interested in becoming involved in research, as the PIs hosting the talks are often looking to recruit undergraduate researchers for openings in their labs.

In Week 5 of Spring Quarter, UBIC hosted **Dr. Lucila Ohno-Machado**, who presented her talk "Current topics in Biomedical Informatics: Data Sharing and Patient Privacy." Dr. Ohno-Machado is a Professor of Medicine and Associate Dean of Informatics and Technology at UCSD School of Medicine, as well as Chair of the UCSD Health Department of Biomedical Informatics and Director of San Diego Biomedical Informatics Education and Research. Students delved into Dr. Ohno-Machado's research focus on

integrating biological data from different levels of analysis to develop accurate models to predict disease and suggest therapies.

Ultimately, UBIC aims to make engaging with professors who head bioinformatics and bioinformatics-related research accessible to undergraduates like you! Keep a lookout for UBIC's Chalk Talk series come Fall Quarter 2022!



Students attend the Chalk Talk with Dr. Ohno-Machado

BEGS x GBIC x BMS Interdisciplinary Networking Prom Night

By Tiffany Zhou | BEGS Representative

Photobooth fun!

When the idea of a "grad school prom" first came up, we weren't sure if the students who asked for it were being serious. But the more we thought about it, the more appealing the idea became. It had been a while since BEGS hosted a large social event just for grad students to hang out, catch up with friends, and have fun. Plus, we hadn't hosted any events where Bioengineering students could meet students from other related departments. However, because the idea was proposed fairly late in the academic year, we only had a few weeks to plan the entire event if we actually wanted it to happen. We figured it would be worth a try, so we hastily put together a prom planning committee and got to work right away!

Every prom needs a cool theme, so we asked students to submit ideas. We received a plethora of very creative and interesting suggestions, ranging from enchanted forest to High School Musical to mitochondria to Theranos. We put the top 5 most common ideas to a vote, and the winner was "Casino Royale"! Attendees were encouraged to dress in semi-formal outfits to fit the theme - we did not want this to be a "jeans/sweatpants" type of event!

Our prom planning committee had less than two weeks to prepare decorations for the event, but we managed to make it work. We constructed big dice out of cardboard boxes and poker chips out of poster board. We also made two giant playing cards - one Queen and one Joker - that people could hold up in front of their faces for photos; these were hand-drawn by Bioengineering grad students **Marianne Madias** and **Shalni Kumar!** We put up a sparkly gold photo backdrop along with beautiful themed balloon arrangements created by *Balloon Besties*, a company run by Bioengineering grad student **Chloe Nguyen.** And to spruce up the tables outside on the patio, we had some elaborate light-up centerpieces designed by Bioinformatics & Systems Biology grad student **Anh Pham.**

DJ Sazon (Jason Wu, Bioengineering) kicked off the first half of the night with some sick beats, followed by **DJ Javi aka DJ Hot Girl aka DJ Throw It Back (Victor Cantu, Bioengineering)**. For a bunch of science nerds, there was a surprisingly large number of people enjoying the dance floor! For those who weren't as inclined to dance, they could partake in the alternative activities that we had set up, including poker, roulette, cornhole, and various board games.

At one point during the event, we attempted to hold a "Best Dressed/Most Creative" competition, but we ended up with too many nominees and also a microphone/sound issue that we couldn't figure out, so we ultimately gave up and just declared everyone a winner!

In the end, our first-ever last-minute interdisciplinary grad student prom was a huge success! Everyone had an amazing time, and we are looking forward to hosting the event again in the years to come!

Lots of socializing at the event!

"Best Dressed" Contest nominees on stage!

Engineering World Health

By Jamie Larsen | EWH Representative

Engineering has never been focused on technology. It has and always will be focused on people and their wellbeing. The most innovative piece of technology will fail compared to a simple piece of technology properly integrated into the community it's serving. At Engineering World Health our goal is to connect technology to the global health issues that most need it. In practice, this means that we host yearly student-run project teams, which focus on issues from water quality to parasite diagnosis.

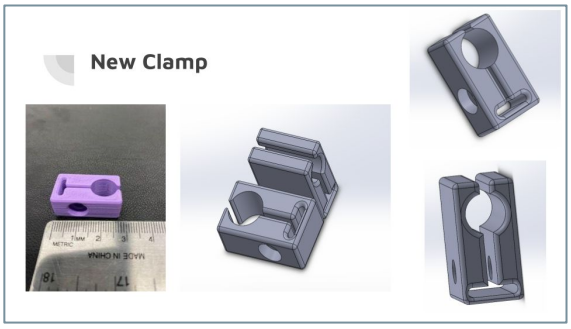
Applications to our project teams are in Fall, and over the rest of the academic year these teams work on researching, prototyping, and testing their ideas in preparation for a submission to the international Engineering World Health Design Competition. The projects teach students both engineering skills ranging from 3D printing to building websites, and also give students a chance to learn about the realities of designing technology for different cultures and knowledge levels. To give you a sense of what these teams are like, we'd like to present you Inside Engineering World Health.

I) Anesthesia Vaporizer

This project aims to address the inadequate resources to provide anesthesia to people in low-resource communities. Normal anesthesia vaporizers rely on compressed gas and electricity which are difficult to obtain in these settings. They are also prone to breaking due to fluctuations in energy grids, as well as due to a lack of knowledge on how to maintain these machines. Our idea on how to address this issue is to create a low-cost drawover vaporizer. Drawover anesthesia vaporizers operate on the patient's breathing instead of relying on compressed gas containers. These low powered vaporizers can be made with a heating device and a chamber to contain the anesthesia as it goes through its phase transition. A breathing circuit and values will be designed and built along with the machine.

II) External Fixation

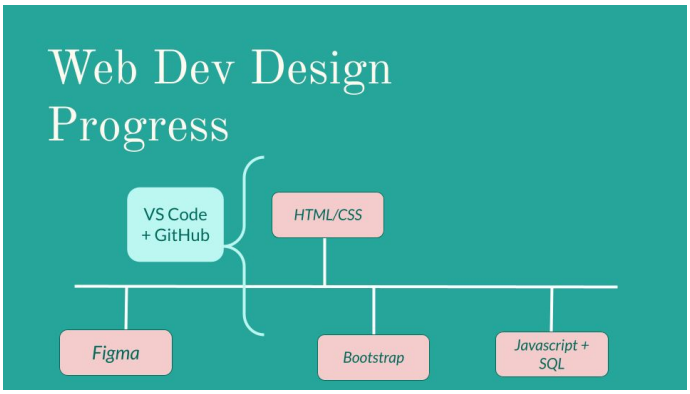
With an increase in urbanization and use of motor vehicles in low resource communities, this project aims to address the spike in the number of bone fractures caused by road accidents. In particular, tibia fractures are particularly common. When these injuries are left untreated, conditions rapidly deteriorate and the possibility of making a full



recovery soon vanishes. There are two common treatment methods: internal fixation of the bone, and conservative treatment using traction tables and splints/casts. The implants required for internal fixation are often only available piecemeal, and doctors are often over-eager to jump into such a surgery. Conservative treatments are meanwhile left to people unqualified to perform them as they are viewed as simple. Due to poor infrastructure and hygiene conditions, minimizing the trauma of surgery is essential to the quality of treatment. External fixation provides an alternative to internal fixation—it is relatively safe, minimally invasive, and often provides better end results.

III) Low Cost Sterilizer

This project aims to address how in surgery, infection control is a challenge. Hospitals in low-resource communities lack adequate decontamination and sterilization equipment, particularly autoclaves. Additionally, a lack of understanding of proper disinfection protocols often contributes to contaminated surgical equipment and greater risk of infection for patients. Our idea on how to address this is a low-cost steam autoclave. This can allow for effective sterilization of equipment in a clinic or hospital setting. Our device can be made with a modified pressure cooker or similar equipment, and it can utilize temperature or pressure sensors to ensure proper sterilization. The design aims to be portable and simple-to-use.



IV) Thyroid Symptom Checker

Our final project is in partnership with another student-organization here at UCSD, Project RISHI. In the village of Vemavaram, India, iodine deficiency, excess salt and oil in foods, and high concentrations of fluoride in drinking water are believed to be causes of thyroid disease. These conditions can lead to hypothyroidism, which is linked to obesity, fertility issues, joint pains, and cardiovascular disease. Current treatments typically involve hormone therapies that require regular monitoring. However, lacking regular access to medical professionals, villagers in Vemavaram must travel to the city of Chilakaluripet to visit a doctor. Our symptom monitoring web application would allow new users to log their symptoms and gain insight into a potential diagnosis, provide links to educational resources, or to help gauge the need to visit a medical professional. The software would also provide patients currently being treated for thyroid disease with a way to monitor their symptoms without the need to make the trek to the nearest health care center.

If any of these projects interest you, at the start of Fall quarter next year EWH will be opening applications to our project teams again. We always like to stress that we are not focused on finding students with pre-existing technical skills or experience. Instead, we are looking for students passionate about global health and interested in making a difference in the world. Keep an eye out for us on library walk and at Engineers on the Green!

If you want to learn more about us, visit our website at ewh.ucsd.edu

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University of California, San Diego Department of Bioengineering

Staff Note

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