



BioE
Quarterly

WINTER 2019

UC San Diego
Jacobs School of Engineering

INTRODUCTION

I often wonder how great painters such as Vincent Van Gogh and Claude Monet craft their masterpieces. The materials they employed are not exactly mysterious or hard to find: most paintings are set on a piece of paper. How then can Monet's *Les Meules à Giverny* rise to such a prominent status while an amateur's drawings of haystacks receive little attention? Though innate talent inevitably contributes to an artist's success, external factors such as training and peer guidance are equally, if not more, important.

Students are, in many ways, similar to a blank piece of paper. Just as paper can be folded into numerous shapes or be painted with different colors, students have the potential to partake in a plethora of careers, both industrial and academic. From high school and early college training, students acquire certain skills such as statistical analysis and writing; but, like a paper without paint, they seldom have the experience to implement their skills on a practical basis. College education provides paints to a blank piece of paper—the student; by providing examples, opportunities, and inspirations in applying theoretical concepts to solving engineering problems, professors in the Bioengineering department help students to evolve as independent thinkers and engineers.

Our winter quarter issue illustrates the many modes in which professors inspire students to put their skills into action. In our interview section, Dr. Peter Chen discusses BENG 1—an introductory course for all bioengineers—that comprises of three design projects: 3D printing, unobtrusive electrophysiology, and programmable sensors. That undergraduates can exercise their academic knowledge on product design makes BENG 1 a valuable instrument in elevating students into actual engineers. Research itself can also be a source of inspiration for students. Whereas Dr. Pedro Cabrales studies cardiovascular mechanics and blood substitutes, Dr. Elliot McVeigh innovates new medical imaging techniques to better identify cardiovascular disorder. The works of these avant-gardes expose students to the many possible branches that young bioengineers can partake. Finally, in an exclusive interview, our department chair Dr. Kun Zhang assesses the value of education and enumerates department initiatives aiming to provide industrial opportunities to students.

Student is the canvas and education is the color. Still, a painting will not be complete unless students actively load their brushes with paints and craft their own image. That necessitates curiosity, passion, and the courage to venture into the unknown. But I believe that students who have decided to enroll in the bioengineering program must have already possessed these qualities. All they need are inspirations and guidance from professors, aiding them to paint a bright image of the future.

Best,
Chak (Julian) Ho
Deputy Editor-in-Chief of BioEQ



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The Bioengineering Quarterly (BioEQ) is a student run publication that covers the people, the research and the events that occur within the U.C. San Diego Bioengineering Department. For Winter 2019, we decided to examine the way in which education inspires students to discover their passion and interest.

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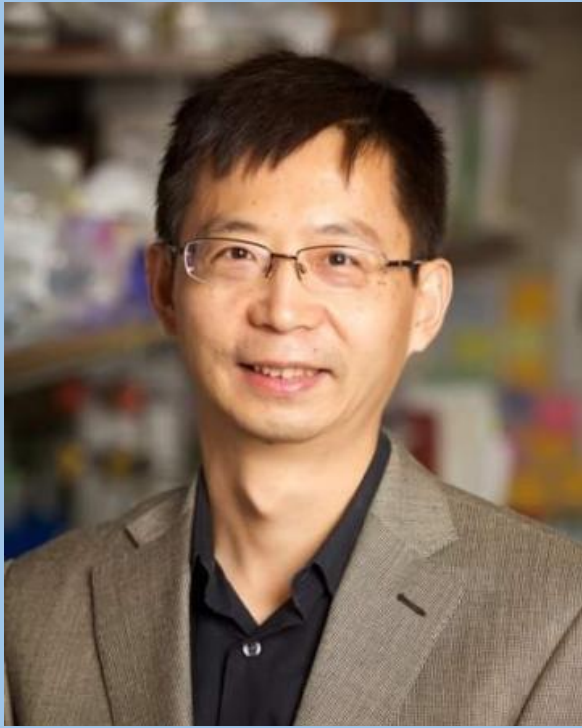
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Dr. Kun Zhang

New Year, New Beginnings: An Interview with the Department Chair

By Chak (Julian) Ho | Deputy Editor-in-Chief



Q: What do you do as the chair of the Bioengineering Department?

A: As the chair of the department, I assess the curriculum of undergraduate and graduate education, respond to concerns or suggestions from the student body, help maintain a climate that is conducive to learning and innovation, assist with graduate student recruitment, and prepare students for post-graduation careers. In addition, I also oversee all faculty members of the department, assigning teaching assignments to professors and evaluating their performance via faculty reviews.

The department chair is one of the most interesting positions on campus because he/she serves as the bridge between administrators and professors. Whereas administrators such as the dean of the Jacob School of Engineering work full-time setting academic policies, professors work full-time

conducting research. Since the two groups have different duties, it is likely that they have different needs and desires. The chair facilitates effective communication between the two spheres, answering demands from each group and communicate them to another.

Q: What's the biggest challenge that you face as the chair of the department?

A: Time management is the main challenge. After all, aside from serving as the chair, I am also a principal investigator running my own research program. I typically allocate 75% of my time on administration and the remaining 25% on teaching and research. Although my job can be trying at times, I take this as an opportunity for me to provide service to the department.

Q: In team work, there a strong emphasis on communication. With my peers, it is relatively simple since we are of a similar age. But when a more experienced individual such as yourself communicate with a student, how do you communicate effectively?

A: In our department, each faculty member typically teaches one or two courses each quarter. As such, over the many years of teaching, I have trained myself in conversing with students. The key to effective communication is to present ideas in simple terms. Instead of focusing on small technicalities from the get-go, I usually show my students a bigger picture of the topic of interest. After students have developed a conceptual understanding on an engineering

topic, I then introduce the relevant equations and technical information that quantify such a concept. Furthermore, I try to minimize my use of jargon and not to assume that students have full background knowledge on the subject discussed. I believe that these strategies can benefit both teachers and students alike in facilitating effective communication.

Q: One economic theory posits that education is an economic signal that enables employers to distinguish high-skilled laborers from low-skilled workers. Do you think that education merely serves as an economic signal? Or is there more value in education?

A: I believe that viewing education as merely a signal is a sarcastic way in evaluating the value of education. Education provides more than just a degree; it offers a certain skill set to students, help them to think critically to engineering or social problems, and allow them to operate on a more professional manner. Furthermore, during the process of learning, students establish a network with their peers and instructors; this network provides guidance during and even after college, exposing students to industrial and academic opportunities. I cannot see anyone become successful solely with a piece of paper that proves that one has graduated from college.

Q: What's the difference between Biology and Bioengineering?

A: Biology is driven mostly by curiosity. A biologist observes a natural phenomenon that

operates within an organism, simplifies the complex behavior with a model, and explains it with a set of principles. Engineering, in contrast, is a more practical discipline. Regardless of different specialization, the key purpose of engineering is design. Provided with a set of objectives and constraints, an engineer aims to create something (i.e. a product) that is useful and practical. In that respect, bioengineering is an extension of biology; after knowing the biological mechanism behind a disease, a bioengineer designs a product that mitigates this ailment. For instance, whereas a biologist is interested in the replication process of cancer cells, a bioengineer aims to develop a medicine that can stop the division of cancer cells.

Furthermore, I think the Bioengineering department place a stronger emphasis on quantitative training than other life science departments. While a lot of courses in biology are descriptive, courses offered by this department stress such concepts as differential equations, linear algebra, statistics, and programming that quantify a biological phenomenon. In summary, our attention to design and computation is what distinguish bioengineering from biology.

Q: What changes will the department be making this year? What specific initiatives do you have in mind that can enhance students' understanding and passion in bioengineering?

A: While this department is one of top bioengineering departments in the country, I understand that we must make continuous adjustments to our undergraduate and graduate education. After all, the world is evolving; self-evaluation and connection with industry are crucial in maintaining our position as one of the leaders in biomedical research.

This quarter, the bioengineering department hosted a town-hall meeting with undergraduates, during which we received student feedback on academic curriculum and industrial opportunities. These town-hall meetings not only establish a method of communication between professors and students, but also provide valuable suggestions on how to improve our department. For each request, we consider solutions both in the short and long run. For instance, in the previous town-hall meeting, one student stated that our senior design project lacked financial support. In response, we allocated some department budget to address the concern; now every team is given 500 dollars to kickstart their project. In the long run, we hope to fundraise more money, perhaps in the form of donations from local companies, to finance our capstone senior design project.

Aside from town-hall meetings, we also aim to strengthen our relationship with industry. To that end, we constructed the Industry Advisory Board (IAB), consisting of leaders of biomedical industries who offer advice on our academic programs and propose potential partnership with the bioengineering department.

Finally, on February 7th, our department hosted the first ever Bioengineering Career Fair—an event catered specifically to bioengineers. While we previously partnered with the Jacobs School of Engineering in hosting job-recruitment fairs, students have complained that there weren't many companies interested specifically for bioengineers. This career fair is a response to students' demand, opening more career opportunities to our undergraduates and graduates.

Dr. Pedro Cabrales

Old Complications, New Principles

By Kevin Yu | Interview Writer

Bio: Dr Pedro Cabrales is a researcher at UC San Diego, having earned his B.S. and M.S. in Mechanical Engineering, and his Ph.D. in Engineering, from the University of Los Andes in Colombia. His current research focuses on topics such as cardiovascular mechanics, imaging, atmospheric gas carriers such as NO, H₂S, and CO, and blood substitutes.

Q: What made you decide to research blood substitutes specifically?

A: I began working on blood substitutes because of a research project I did as a grad student back home. I had to develop an artificial carrier that did not need refrigeration and could be kept stable for a long time without the need for refrigeration, since blood access, availability, and shelf life are limited. Therefore, we had to create a more resilient, non biological alternative to blood.

Q: Were there other classes, undergraduate or graduate, that helped you prepare for this work?

A: I took similar classes to what most undergrads here take, such as engineering and human physiology. It was interesting to see all the things blood did besides transporting oxygen, and making the cardiovascular system work.

Q: From my knowledge, there are three different classes of blood substitutes: Perfluorocarbons as oxygen carriers, molecules designed to mimic hemoglobin, and methods to extract actual hemoglobin from live cells.



Which does your lab specialize in?

A: We work in all three classes you described. We develop perfluorocarbon molecules and optimize the formulations in order to make them more compatible with human blood. Their main limitation is compatibility with the blood that already exists in the cardiovascular system.

For hemoglobin-mimicking molecules, we have projects that examine the method of action for hemoglobin in other species, ranging from simple animals to complex mammals. Based on how they work, we try to create synthetic or recombinant approaches to mimic their functionality. These molecules imitate the structure of hemoglobin from simple animals, like worms or fish, and then we modify them to function in mammals. We are picking up mechanisms that evolution has implemented for oxygen transport in other species, and using those to make blood substitutes for

humans under specific conditions. Imagine if someone were to climb Everest, they could be equipped with blood that captures more oxygen from the air. Or if someone had suffered a hemorrhage, we could restore oxygen transport with a lower volume of oxygen carriers relative to the amount of blood initially bled.

Q: So how are these going to be implemented into the body itself? Are they going to be given intravenously like current blood transfusions?

A: Since they have to go into the blood vessels, and fill the cardiovascular system, they'll have to be injectable. And that's one of the bigger challenges we currently face; if they're injectable, then they need to be compatible with all of the organs and tissues in the body.

Q: Does your work aim to treat any specific illnesses/conditions, such as asthma or sleep apnea?

A: Sort of. We can use blood substitutes to mitigate the issues that those conditions create, and go beyond the standard oxygen-carrying improvement provided by a blood transfusion. The idea behind the oxygen alternatives we are working on is to either enhance human features, or to mitigate the effects of disease. For example, it won't treat asthma, but it will at least enhance the oxygen transport for someone who is struggling with asthma. Another example is a project we worked on involving malaria. The blood substitute did not kill the malaria parasite, but it does at least let oxygen and nutrients be transported as the patients received the treatment they needed. So overall, we are

working to address functions lost due to the disease, reducing the side effects of the disease itself.

Q: Finally, if this research is translated into some kind of product to be sold, it could potentially give wealthier individuals an advantage over people who couldn't afford the treatment, so do you see any societal impact resulting from this?

A: It's a problem with any development in the biomedical field. One of our goals is to develop a product that is reasonable in cost to allow everyone who needs it to have access to it. Blood substitutes will enable people who have religious reasons (such as Jehovah's Witnesses) or other preferences against receiving blood to have an alternative. This is especially important for cases when a transfusion could save a life, but blood is not an option.

Dr. Peter Chen

BENG 1: First Step for UCSD's Bioengineers

By Jenny (Yichen) Xiang | Interview Writer

Bio: Professor Chen, a Project Scientist and Lecturer in the UCSD Bioengineering Department, was also once an bioengineering undergrad student at this school. He was Co-director of the Greater Los Angeles American Heart Association Cardiovascular Research Laboratory, before coming back to UCSD. His field of research includes many aspects of bioengineering, for example, hemodynamics, in-vivo videomicroscopy, cartilage injuries and implantable biosensors. He is also a recipient of the Malpighi Gold Award from the European Society for Microcirculation, and the winner of Distinguished Teaching Award at UCSD.



Q: As one of the program's first graduates, can you explain what bioengineering at UCSD was like in the past versus in the present?

A: Bioengineering in UCSD was started in 1966 by Prof. Fung, Prof. Intaglietta and Prof. Zweifach. At that time, it was mainly a graduate studies program and there were no Bioengineering classes (for undergraduates). I came to UCSD in 1968 after graduating from high school in Hong Kong, and I picked up the Bioengineering major because it sounded 'exciting'. Back then, Bioengineering was a program under the Aerospace and Mechanical Engineering Sciences department, known as AMES. We took classes in math, physics, biology, chemistry, and engineering to complete the Bioengineering major. The only bioengineering-specific class was Continuum Mechanics taught by Professor Fung. The Bioengineering Department under the Jacobs School of Engineering was established in 1994

by Prof. Chien, and as you know, there are now four undergraduate tracks with Bioengineering classes specific for each track.

Q: Did they have the BENG 1, an introductory course back then?

A: If you think you are interested in Bioengineering and want to pursue it as a major, BENG 1 is a most important and interesting class. Professor Fung started this class in 1996. His initial thought for introducing this course was to encourage students to start thinking, as early as their freshman year, about what they want to do and could do as bioengineers, and jump right into working on a design project. Back then, we divided students into small teams that can range from 3-8 members in each team. The teams will come up with their own projects focusing on what they believed to be important and interesting. Although freshmen may not have the ability to

complete such a challenge, Dr. Fung encouraged them to be innovative. We knew some of the projects the teams came up with may not be possible or practical, but we encouraged them to keep working on the project. At that time, there were no lab sessions, so these were all paper projects, which was lacking in practical and hands-on experience compared to today's BENG 1. Meanwhile, during each week's lecture, Professor Fung would invite one or two faculty members to present their work to the students. This was probably the best way to introduce the students to the faculty and provide them with a good understanding of what Bioengineering at UCSD is about.

Q: How has BENG 1 changed?

A: In the beginning, BENG1 was a 1-unit class which met for 80 minutes once a week on Mondays, during the winter quarter. The first half of the class would be professors talking about their research and the other half would be students presenting their projects. There were no midterms or final. As the enrollment for BENG1 increased, BENG1 adopted a team taught format. Around 2002 or 2003 Prof. Chien became the principal instructor for BENG1. One issue he noticed that limited the amount of materials we wanted to present was the two holidays on Monday in the winter quarter. He switched the class to Wednesdays, to be able to invite more faculty members to speak and we also started to hold weekly sections when students can gather to discuss their projects.

In 2015, the Dean of Engineering was most enthusiastic with the plan to incorporate

engineering design lab projects in all undergraduate class levels. UCSD BENG1 may be the first Freshman engineering class in the nation that offers hands-on lab experience. We started with three design projects: 3D printing project led by Professor Sah, unobtrusive electrophysiology lab led by Professor Cauwenberghs, and an implantable and programmable sensors project led by Professor Gough. In reducing our students' workload, this year we only offered two projects. With the incorporation of lab projects we petitioned to change BENG 1 to a two unit class.

At one time, Bioengineering had a pre-med track, and that might have caused some confusion because some students thought that they have to major in this track if they want to go to medical school. There was one year when the enrollment for BENG 1 reached 280. The pre-med track was discontinued.

Q: As a professor, how do you think this course prepares your students for their major?

A: I think bioengineering, even today, is a fairly new and diversified subject. A lot of students are not sure what it [the major] is about. BENG 1 is a fact filled introductory course for our students. It shows them what is Bioengineering, focusing on the work in the UCSD Bioengineering Department, it teaches design and teamwork skills, and also develops, for our students, an awareness of ethical issues in bioengineering. When our students graduate and start their own careers, they will likely work in teams for engineering tasks. This year we randomly assigned the students to

different groups to create a realistic environment where students can learn to situate themselves within a team of strangers. We want our students to learn right away how to work with others to better prepare them for the future. We are engineers that design and make devices which impact people's lives, and we have emphasized the importance of this consequence with lectures in ethics. We want our students to be aware of the social and economic impacts of the products they come up with. We insist our students should complete a library tutorial to learn how to find and quote references properly.

BENG 1 is a p/np class but we grade the homework and presentations seriously. We want the students to know what to expect in regular Bioengineering classes. There are 19 TAs this year working with the students to prepare them and to inform them what lies ahead if they continue with the major. We insist on attendance for this course because we want the students to interact with our faculty members, discover their personalities and seize the opportunity to further study the field of their interest. And by attending the class, students will know if they truly want to continue with the major. ”

Q: In BENG 1 we learned how to process CT images with specialized software. How do you think the development of technology, especially computer science, contributes to the growth of bioengineering?

A: It is very related. Frankly, Bioinformatics is essentially computer science. When we talk about Bioengineering, we are talking

about benefiting the medical field too, and that involves a lot of data compilation, (especially clinical), and computation, which is very related to computer science.

Q: As a widely respected professor, you have a very long list of research interests. When did you start to do research? And what was your very first research project?

A: When I started my undergraduate studies at UCSD I did not have a clear idea what I will end up doing. The second year, after taking Continuum Mechanics from Professor Fung, he asked if I wanted to do something during the summer. I started by helping with running some computer programs on an IBM mainframe computer that occupied the whole ground floor in Urey Hall. Prof. Fung later asked me to figure out a way to measure the two-dimensional mechanical properties of the mesentery, a thin membrane in the abdomen. At that time there was a pulmonary team working on large dogs, and Professor Fung told me I can get a piece of the dog mesentery from them. That was the first time I got involved in research, and I really started from phase zero because Professor Fung did not tell me how I should do it. I had to figure out how to stretch a piece of tissue, how to load it two-dimensionally and how to make measurements. It was a crude experiment and I still have the lab notebook I used for that summer project. The year was 1970. Very important that you keep a good lab notebook for your record.”

Q: As a winner of the Distinguished Teaching Award, what advice do you have for those thinking of majoring in bioengineering, but are hesitant?

A: Bioengineering is a very popular and challenging major in UCSD, and we are aware some students pick this major because it sounds cool. You should follow your interests. For students who think they are interested in bioengineering, attending the BENG 1 lectures will be helpful to decide whether they should consider majoring in it. Talking with a few faculty members in the department and some fellow students will further help you decide whether to enter this field. Once committed, it is a lot of hard work but the reward is great. I am still in touch with many of our graduates and whether they ended up with industry, academia, government or in the clinical field they seem happy and give a lot of credit to our program.

Q: What should bioengineering students focus on to better prepare themselves for their future career?

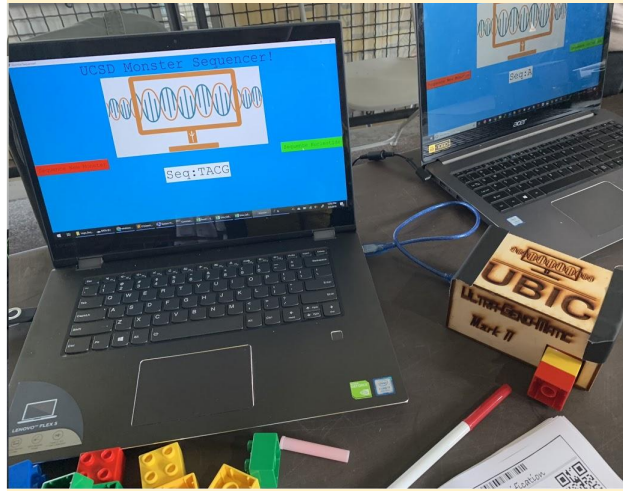
A: You should work hard in the Bioengineering classes, especially the ones that you have to write reports and make class presentations, like BENG1. Try to take some classes in other departments to broaden your knowledge base. Not everyone knows what he/she wants to do in the future. It is always beneficial to explore new areas. Networking is important. I think it usually takes students some time to realize how important it is to talk with professors often. Sooner or later you will need to find a job, go to graduate school, or do something else. It will make a big difference if you can get

a good letter of recommendation from people who know you well. Developing a good relationship with your professors early on is crucial, and it can provide you with opportunities for research projects. Learn to write well, and prepare well for presentations. You will be judged by how well you write and how you present yourself constantly. ”

S.D. Festival of Science and Engineering

Epiphany and Rediscovery

By Chak (Julian) Ho | Deputy Editor-in-Chief



The San Diego Festival of Science and Engineering (SDFSE) is an annual event hosted by the Biocom Institute to expose children K-12 to the fascinating fields of STEM (science, technology, engineering, and math). This year's extravaganza, spanning from March 2nd to March 10th, attracted more than 75,000 attendees, showcasing San Diego's growing awareness of STEM.

Featuring industrial demonstrations, live performances, and interactive activities, Expo Day in Petco Park was perhaps the most celebrated day of the week long festival. As an involved member of the San Diego community, our Bioengineering department was represented substantially in the Expo by its student organizations: BMES, UBIC, and BEGS.

Personal Experience

Upon entering Petco Park, the first thing I saw was a crowd of children, gathering around the stage where an intriguing demonstration was about to take place. I initially eschewed the idea of joining the crowd; after all, how would a 20-year-old adult like me fit in with the children?

But their excitement resonated within me, tempting me to walk closer and closer to the stage. What was that, I wondered? Still pondering the question, a loud "BOOM" suddenly filled the air. The demonstration had begun.

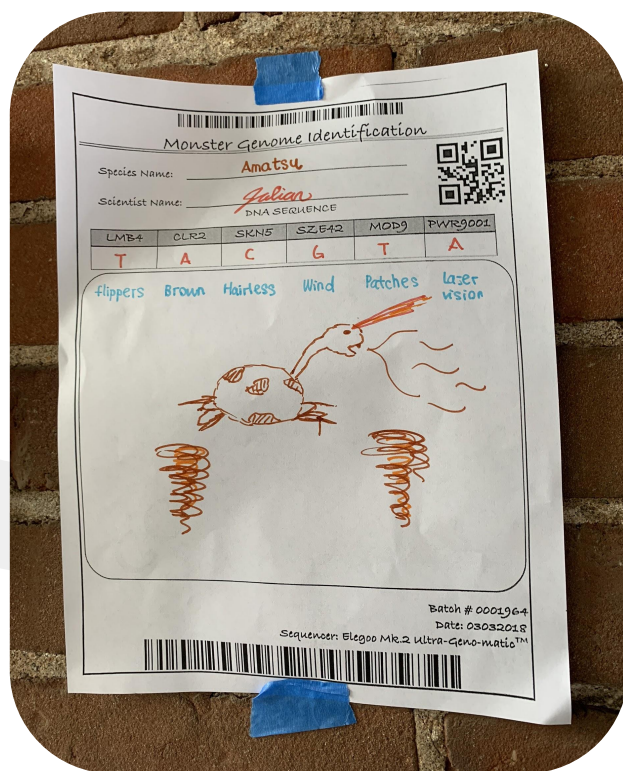
It was the explosion of a sealed bottle of liquid nitrogen. Before arriving to the scene, a scientist had poured liquid nitrogen into a plastic bottle and fastened the cap; boiling at room temperature, liquid nitrogen dramatically increased the pressure inside the bottle, causing it to erupt. The kids cheered at the sound, and so did I. In that moment, the eyes of a child caught my attention; they were filled with pure joy and excitement. I took a deeper look, and I saw my younger self.

When I was a boy, I found science to be interesting and fun; I loved it so much that I decided to major in Bioengineering; Biotechnology in college. But as I progressed further in my studies, I began to view my list of coursework as no more than a checklist to cross out, and my degree a means to procure a

job. My passion in science had, in a sense, waned. But in the eyes of the child, there was no midterms or piles of homework to worry about. It was the explosion, and more explosions, with each a burst of laughter and a dose of jubilation. I used to be that child, and now I am not.

After the demonstration ended, I decided to tour the booths of different companies and organizations. The first that I visited was the booth of the Undergraduate Bioinformatics Club (UBIC). One of its members, York, invited me to participate in a hands-on activity. “It was for children,” I thought, but I tried it anyway. First, I was instructed to construct a 6-block rectangular prism from 4 types of Lego Duplo blocks – red, blue, yellow and green. After completing the structure, I inserted it into a machine, which immediately printed out six letters: T, A, C, G, T, A, the bases of DNA. Each letter corresponded to a specific trait, and I had to draw a monster exhibiting all those traits—laser visions, flippers, and the ability to blow wind. A younger boy had stood next to me sketching his monster but I was not embarrassed at all; I unabashedly drew my own creation: Amatsu. Later on, I toured the BMES and BEGs booths, earnestly participating in their design challenges. I built a bacteriophage out of plastic balls and chenille wires, despite the fact that it was meant for children. Gradually, I found myself to be a kid again.

Suddenly, I heard a loud “BOOM” again. On the same stage as before, a scientist was shooting ping-pong balls with a pressurized gun. One of the balls flew into a pile of branches and brush clippings; I instinctively approached the pile and picked it up. Upon touching the ping-pong ball, I finally found my answer!



My passion for science and engineering had not been extinguished, but rather,

Like the ball that was buried by the pile of cuttings, my passion was merely enshrouded by my stress and apprehension of the future.

This passion was the force that motivated me to join the crowd of children despite the obvious age difference; this passion was the exact reason I partook in bioengineering. The epiphany reminded me of my boundless curiosity during childhood and my desire to learn more for the sake of learning. College study is not about getting an A in class or earning credentials for a high-earning career; it is about quenching the endless thirst for knowledge. This is my passion—to learn, to explore, and to discover.

Demonstrations

UBIC - by Yujie Zhang

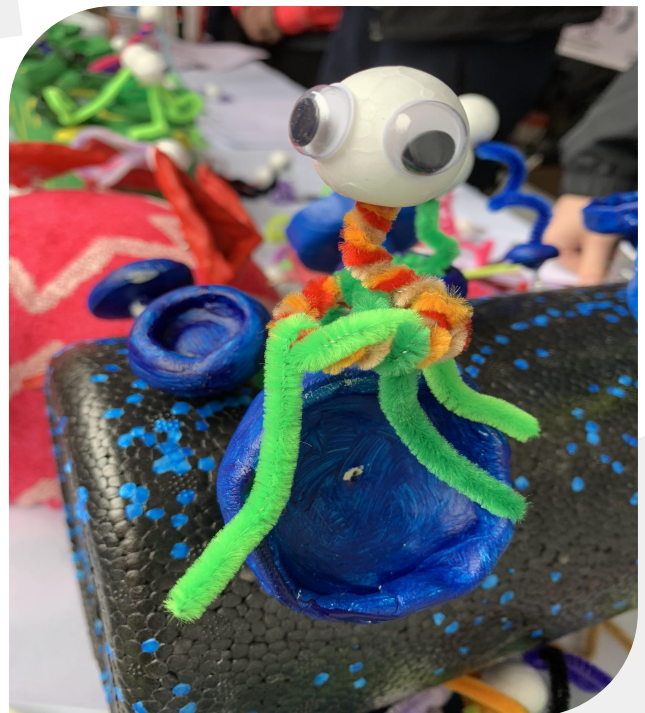
At SDFSE, the Undergraduate Bioinformatics Club (UBIC), together with our graduate counterpart GBIC, exposed middle school and high school students to the basics of genetics. Our first activity introduced the concept of DNA base pairing; given a template DNA sequence, children were tasked to build a complementary strand with velcro letters. Our second activity was a more in-depth overview of sequencing. First, participants built a "DNA sequence" with colored Lego bricks and inserted the product into a small color sensor box. After the sensor box printed out a series of letters, participants decoded the message--each letter corresponding to a trait--and drew a monster exhibiting those traits.

BEGS - by April Aralar

The Bioengineering Graduate Society (BEGs) had two demos in the San Diego Festival of Science and Engineering, the first on engineering phages and the second on tissue engineering. Using plastic balls and chenille wires, participants created bacteriophages with tails that matched the shapes of receptors on bacteria. This hands-on activity mimicked the way in which bioengineers design targeted treatment to bacterial infections. In our second demo, we showed children models of heart sections, telescoped portions of the bone, and paintings of skin anatomy. We then discussed bioprinting, prosthetics, grafts, and other engineering solutions pertinent to tissue engineering.

BMES - by Frank He

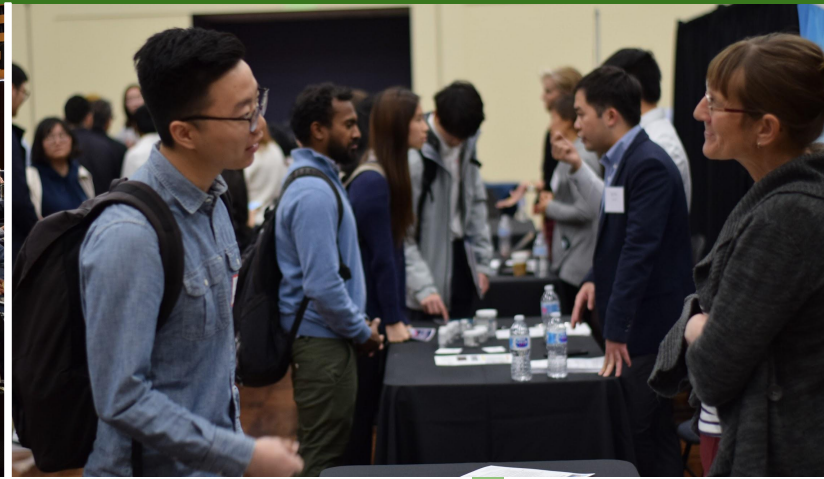
This year, the Bioengineering Medical Society (BMES) centered on the theme " Diabetes: Prevention & Bioengineering Solutions ". Our first activity focused on nutrition and sugar consumption in the US, in which participants tested their nutritional knowledge by playing a matching game with common food products and their sugar content. The second activity provided participants insights into the bioengineering design process. With an electronic device that mimicked pancreatic activity, our presentation aimed to inform viewers about blood glucose monitoring and insulin releasing devices.



The Bioengineering Career Fair

First Wind of Change

By Seth Barragan | Features Writer



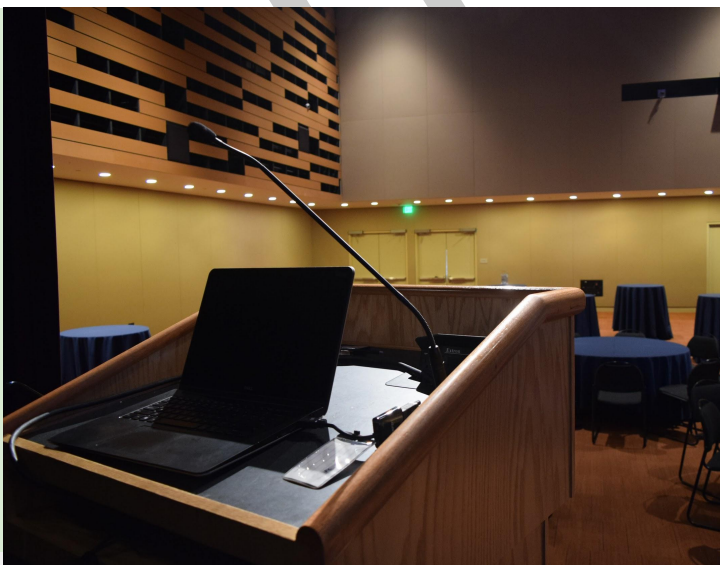
There is no doubt that UCSD students face a surplus of campus-hosted opportunity to engage in STEM careers. Our bioengineering community in particular offers a generous assortment of resources to its students through the likes of the Bioengineering department and affiliated student organizations. However I, like many of my peers, were surprised to find that bioengineering relevant industry lacked enough representation in tech-heavy career fairs.

Now, after two years of preparation, our very first Bioengineering Career Fair has proven to be a welcoming start of change. This extravaganza was headed by not just one advocating student or department member, but by multiple student organizations—Biomedical Engineering Society (BMES), International Society for Pharmaceutical Engineering (ISPE), Undergraduate Bioinformatics Club (UBIC), Bioengineering Graduate Society (BEGS), and Tau Beta Pi. Together, they formed the Student and Industrial Relations Committee (SIRC), aiming “To develop sustainable and scalable industry connections for the UC San Diego Bioengineering students”. Complementing

these student organizations were individuals of industrial seasoning, most notably Industry Relations Director Isgard Hueck, and Industry Advisor Lou Obertreis, whose invaluable contributions kept the committee's expectations both effective yet realistic. Of course, no committee meeting would be possible without the SIRC chairs, the most recent being Alexandra Muise.

SIRC intends to represent a voice greater than its own seeding at UCSD, humbling itself with an awareness of actual industry needs. One of our goals is to give startup and smaller scale companies a presence in our campus, establishing a mutual UCSD-industry relationship distinctively iconic to this particular event for years to come. Collaboration with industry via such device as student internship is also crucial. Isgard contributes to this endeavor by offering companies implementation of internship programs with UCSD academic credit. This is particularly useful to companies lacking the personnel or experience to implement their own internship programs.

With this in mind, the career fair credits much of its success to industry extending its own comfort zone. An encouraging example includes Chromacode's Chris MacDonald, who took the initiative to host an elevator pitch workshop on campus for the students. While biomedical companies unfamiliar to UCSD were invited to join, those already affiliated to our campus also saw this career event as a valuable opportunity to try something new. Industries that participated in the Bioengineering Career Fair ran the gamut from genomic sequencing to biomedical device development, including such companies as Genomatica, Truvian Sciences, Vertex Pharmaceutical, Cibus, Keck Graduate Institute, Thermofisher Scientific, Allegro 3D, Nuvasive, and Daré Biosciences.



It was evident that the Bioengineering Career Fair strengthened our relationships with local industry. With well over 200 students attending, campus interest confirmed the need for a career fair catered specifically to bioengineers. Finally, on behalf of the UCSD Bioengineering community, I would like to thank every student, faculty, and industry representative for contributing to this extravaganza.

Switching into Bioengineering

BMES Freshman Committee Event

By Vania Pena | Features Writer



UC San Diego is a pioneer in the ground-breaking field of bioengineering. While only a couple decades old, the department has grown substantially since its creation, currently housing 4 different bioengineering majors: Bioengineering, Biotechnology, Bioinformatics, and Biosystems.

As recently admitted students quickly learn, bioengineering is an impacted, highly competitive, and academically rigorous program. Built on the cornerstones of engineering, biology, chemistry, and computer science, accreditation in bioengineering is an invaluable degree that opens the doorway to many possible applications in the working world. This doorway, flung open nearly half a century ago, grows wider still as the truly adaptable nature of the program becomes recognized further.

Every year, qualifying UCSD students are given the opportunity to apply to transfer into one of the four bioengineering majors in the department. Within reasonable time before the opening of the department's transfer application, UCSD's Biomedical Engineering Society (BMES) once again held their informational session, "Switching into Bioengineering" on February 7th, detailing this process. Hosted this year by Freshman Committee chairs, Kendra Worthington and Alan Lunardhi, the session functions to educate any curious underclassman on the roots and fundamentals of the bioengineering department, as well as the logistical information on how to become a part of it.

At the start of the session, bioengineering department professor, Dr. Bruce Wheeler, introduces the field itself, describing the versatility of each major and of the department as a whole. Bioengineering, primarily applied to the medical field, is utilized widely; from synthetic biomaterials to medical imaging techniques to genetic analysis. A synonym for bioengineering is versatility; the field can be described as any area of biology united with any area of engineering in any proportion. The field of bioengineering itself is still growing, and it is expanding fast as the desire to apply engineering principles bolsters the creative innovations of the biomedical field.

While all housed within the same department, there are 4 distinct paths one could take when entering the program:

Bioengineering: Bioengineering, considered the department's broadest major, it is strongly rooted in mechanics and physics/biomechanics, especially as applied to cardiac tissues. This pathway is ideal for prosthetics development and medical device development.

Bioengineering: Biotechnology, the most popular major as far as the number of enrolled students go; this subject reflects the continuum from chemical/biochemical engineering materials to tissues to molecular engineering. This pathway is ideal for tissue and stem cell engineering, as well as biochemically based sensors (e.g. glucose detection).

Bioengineering: Bioinformatics combines computer science with the biological field, focusing on computation for genomics, molecular biology, and "wet" biological systems.

Bioengineering: Biosystems, the department's newest major, contains a mixture of electrical engineering, modeling, and computation. This pathway facilitates understanding, analyzing, and modeling multidimensional dynamic systems, whether the scale be of a molecular, physiological, or medical nature.

As explained by bioengineering undergraduate intake advisor, Vanessa Hollingsworth, the application opens only once and at the same time every year. Each student has one chance during the fall quarter of their sophomore year to apply to a single bioengineering major of their choice. Application eligibility, she explains, is based solely on GPA obtained from a list of specific screening courses, the course list varies depending on the selected pathway but consists of fundamental courses such as chemistry, physics, and biology. The actual number of open spots within each major is not a fixed number, however, availability varies every year and cannot be determined until after all the applications are in. Vanessa closes her informative speech with the reminder that any further questions can be directed to the Bioengineering Virtual Advising Center (VAC), which can be found online.

At the close of the event is a panel of four, actual bioengineering students, all of which can empathize the most as they, too, have successfully applied and have been admitted into the bioengineering process. The panel consists of a student from each of the four disciplines: Frank He (Biotechnology), Shoun Matsuka (Bioengineering), Yuren Dong (Bioinformatics), and Daniel Cao (Biosystems). Their insight proves invaluable to all attending students, as there is only so much to be learned from application logistics and department history, personal experience proves to be the best way to accentuate the realities of the application process. Though all members recount the rigorous nature of their screening course eras, there were many crucial lessons learned that made the experience worth enduring.

Among the words of wisdom is the reminder to maintain balance, don't overload yourself in the screening courses; though the desire to do so much in so little time is compelling, it is an easy way to burn out. Furthermore, in your efforts to make your way into the field, it is a good opportunity to evaluate whether this field is what's right for you. Don't apply to a major only because it looks easy to get into; have a back up plan and find friends within the department that will be undergoing the same journey as you.

And most importantly is to not worry yourself too intensely over the application. Being notoriously difficult to succeed in means that there is a chance for there to be some failure; don't lose yourself in this failure though, as there are plenty of other opportunities to work in the bioengineering field, as explained by Dr. Wheeler only moments earlier. Evidently, a successful bioengineer isn't the student who majors in the field, but the student who dedicates their interest to it.



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Dr Elliot McVeigh

Advancing Heart Analysis via CT Scanning

By Michael Hu | Research Writer

Bio: Professor Elliot McVeigh attended the University of Toronto for both his bachelor's in physics, as well as his PhD in medical biophysics. Subsequently, he joined the faculty of the Biomedical Engineering Department at Johns Hopkins University, and from 2007 onwards, he served as the departmental chair. He remained in this role until 2015, at which point he moved to UC San Diego with a joint appointment in the school of medicine and school of engineering.

Over the last several decades, Professor McVeigh has contributed greatly to the field of medical imaging by developing and optimizing techniques for early identification of cardiovascular disorders and procedures to be used in preventative care. While the majority of his research has centered on MRI-based diagnostic imaging, this article will focus more on his recent work in optimizing CT-scan technologies as both more effective and more accessible diagnostic alternatives.

Each year, millions of individuals suffer either directly from a myocardial infarction, or from related downstream complications such as congestive heart failure and arrhythmias. Because the lasting damage from an infarct is extremely difficult to mitigate, a significant amount of research has gone into identifying potential precursors or characterizing significant post-infarct remodeling so that measures for preventative care can be put into place.

Historically, characterization of heart function and identification of potential heart pathologies



has been conducted using tagged MRI, in which multiple sections of the heart are imaged over time, and the data is post-processed to produce high-resolution, 3D images. This allows for identification of potential problems, such as ventricular dysfunction or abnormal fiber orientations [3]. Unfortunately, many facilities have limited access to MRI technology, and MRIs as a whole are non-viable in patients who are already compromised with pacemakers or defibrillators. To address this, Professor McVeigh has begun to explore the possibility of using cardiac CT-scans to obtain the same data. Traditionally, CT scans have had inferior resolution compared to MRI and come with the additional risk of radiation exposure [1]. However, recent improvements to both CT technology as well as computational post-processing techniques have significantly mitigated these shortcomings [1].

In particular, researchers under Professor McVeigh have developed a technique called Stretch Quantification of Endocardial Engraved Zones (SQUEEZ) to quantify left ventricular function via algorithmic detection of wall deformations [5]. Examining the left ventricle, specifically its functional performance as well as the presence of lesions, is a non-invasive method to identify coronary artery disease [4], which is a known precursor for both myocardial infarctions and heart failure. Traditionally, this is achieved using MRI to produce multiple high-resolution 3D images of the heart over time. However, researchers under Professor McVeigh conducted an experiment in which they analyzed nine infarcted animal model hearts using both cardiac MRI and a CT scan. The analysis was followed by SQUEEZ to calculate circumferential shortening (Figure 1a-b) and ejection fraction, both of which are common measures of left ventricular function [4]. Results indicated that measurements were extremely similar across the two methodologies, suggesting that CT had the potential to diagnostically substitute for MRI in this context.

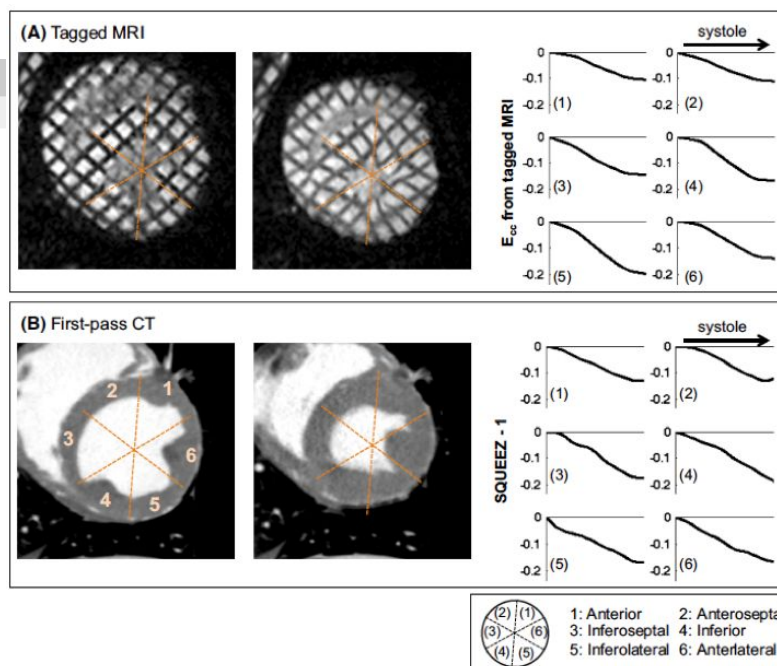


Figure 1: Circumferential shortening of the left ventricle of an infarcted heart as measured by a) Tagged MRI and b) CT scan followed by SQUEEZ processing.

This methodology has since been successfully extended to human patients. In particular, an exploratory study was conducted in which SQUEEZ was applied retrospectively to right ventricular CT scan results from fourteen patients. In doing so, it was possible to identify the presence of the Tetralogy of Fallot, a rare genetic disorder causing multiple deformations in the heart, thereby distinguishing afflicted from healthy patients [1].

Moreover, SQUEEZ has since been applied to obtain clinically relevant data that is not ordinarily obtainable, even with MRI. Specifically the functionality of localized regions of the heart was analyzed by obtaining high-resolution CT scans and subsequently analyzing with the SQUEEZ algorithm to obtain values for regional strain, a common measure of heart function (Figure 2). This was performed successfully for twenty-five subjects using results from CT scanners from three different suppliers, confirming the flexibility and applicability of the technique [2].

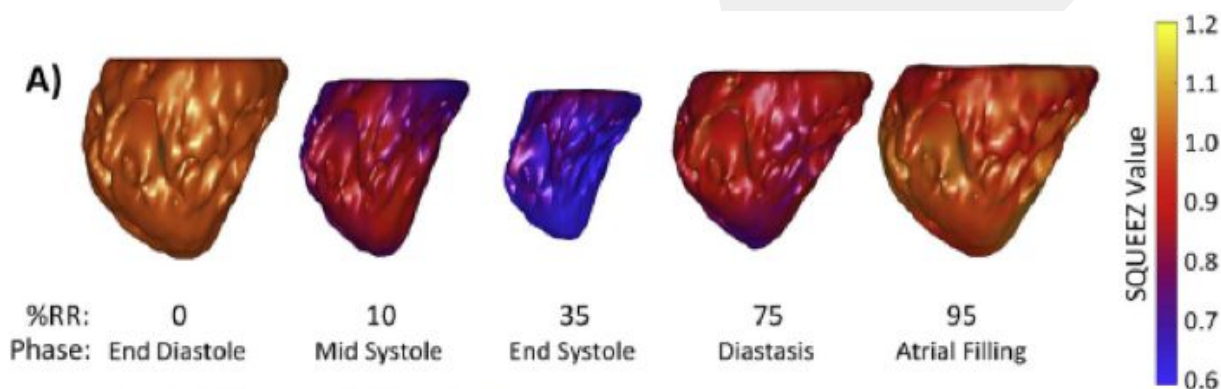


Figure 2: SQUEEZ-obtained measurements at different timepoints over a single heartbeat tracked via CT.

In this sense, Professor McVeigh's work with CT technologies replicates, and in some cases improves upon, the diagnostic ability of MRI. This not only provides notable advances in the context of research, but also increases the accessibility of such diagnostic methods in a clinical setting.

Citations

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A LETTER FROM THE EDITOR-IN-CHIEF



TO OUR READERS:

A mountain of appreciation to all of you, your eagerness and curiosity is what keeps our pages turning. It makes me very happy to see our newsletter grow and progress, because it is a testament to the growth and progress of our team. Here at the close of the our second quarter, I am delighted to see our doors open wider.

The success of this issue was not the product of a single person but the convergence of our collective efforts. Thank you to every single person behind this quarter's issue: Thanks writers for being on top of it, and to our producers who held so much enthusiasm. Thank you sevenfold to our department administrators and to all our article muses, who may not have written or edited the words, but they are the cornerstone to their meaning.

Good luck to everyone in this home stretch of a quarter, I hope that the BioEQ continues to provide a welcome service and reliable guidance to the students it was written for.

Will see you again very soon,

Vania Peña
BioEQ Editor-in-Chief

FROM THE DEPARTMENT TO YOU

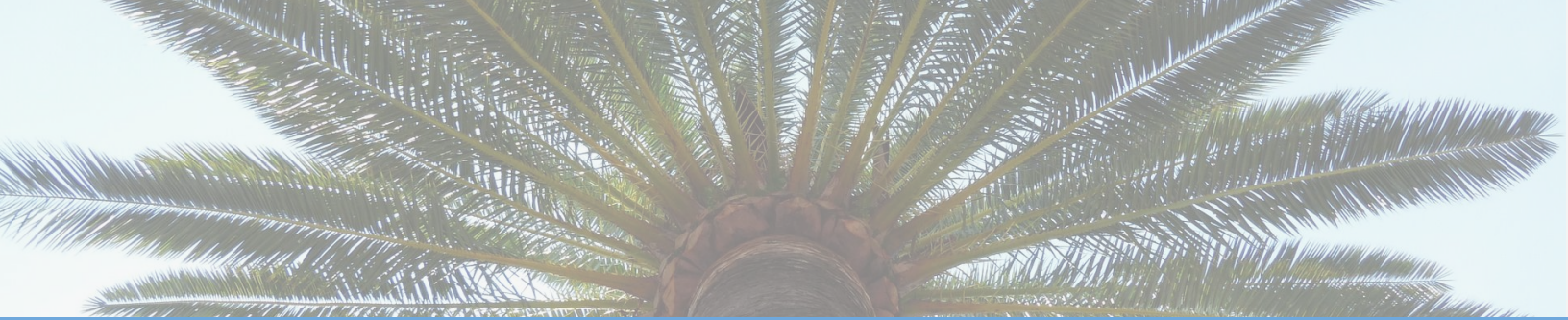
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STAFF NOTE

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