The Catalyst

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Dear Catalyst Readers,

My name is Loren Suite and I am honored to present to you the Summer 2018 edition of The Catalyst. I am currently a junior and I have been involved in the production of The Catalyst since my freshman year. I have had experience in every aspect of the production of this journal from editing to writing, designing, and publishing. The 9th edition of this journal is a labor of love and I am excited to say that we have expanded further than just showcasing undergraduate students research. We are now heavily committed to writing articles about professors, competitions, companies, and topics that are at the forefront of bioengineering. This expansion is evident in this issue and will continue forward so that we can be the best resource possible for the bioengineering community and those invested.

This issue offers a robust selection of engineering topics from medical devices to prosthetics design. We focused on organizations present on campus such as Quality of Life Plus and Enable and the amazing work that they do for a variety of communities worldwide. Both organizations are passionate about improving the quality of life of others through engineering innovations. Our editorial board spoke with professors in bioengineering such as Dr. White to gain an insight into the purposeful design of their courses and their educational backgrounds. These professor perspectives we hope will bring the readers a behind the scenes view of the bioengineering department at UMD. In this edition we decided to focus on comparing wet labs and dry or computationally based labs to help students trying to decide between which type of lab to join. In order to accomplish this, we spoke with Dr. Montas and Dr. Jay to draw strong distinctions between the two types of labs and the kind of work they do. Past Catalyst members Kevin Pineault and Luke Peterken took the opportunity to express what The Catalyst meant to them and to discuss where they are now. From A Bioengineer's Guide to University and Beyond to Biobytes coverage we were dedicated to providing you, the reader, with an issue that everyone can find something to take interest in. Finally, we have the classic research pieces by some of bioengineering's hardest workings students, Nikita Kedia and Niall Cope.

Serving as the Editor-in-Chief has been a great honor and I would like to thank The Catalyst board members, my family (Tiffany, Chris, Jenna, and Papa), and one of my biggest supporters, Monica for encouraging me to produce an issue I am proud of. It is truly amazing how much goes into producing this journal and on behalf of the entire editorial board I would like to thank you for picking up this issue, supporting us, and investing your time to read what we spent so much time preparing.

All the best,

Loren Suite

Loren Suite

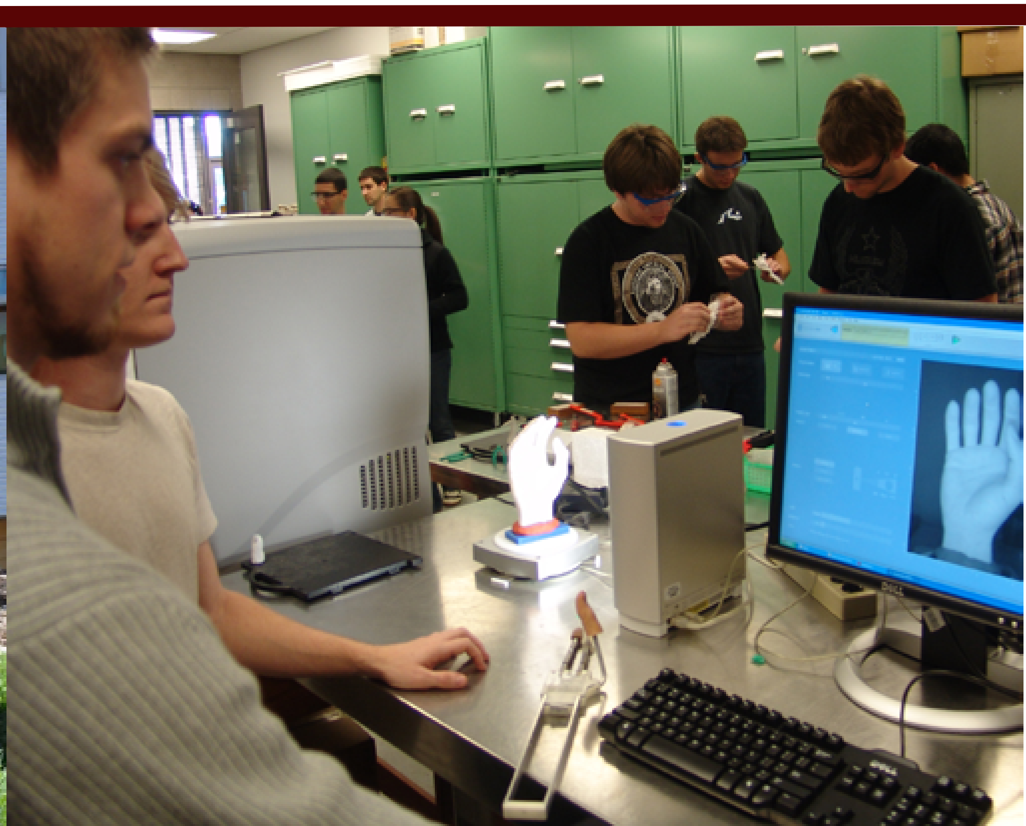
LETTER FROM THE EDITOR

IN THIS ISSUE

QUALITY OF LIFE PLUS

Engineering an improved quality of life for those who served



Quality of Life+

Interview Conducted by Loren Suite, Editor-in-Chief

WHAT IS QL+ ABOUT?

QL+ is a non-profit organization that consists of the main national QL+ Program and the QL+ Clubs (also called Student Associations).

1. The national Quality of Life Plus Program (QL+), through unique partnerships with engineering schools at leading universities across the country, sponsors and directs a wide array of technology development projects aimed squarely at improving the quality of life of our nation's wounded veterans, active duty military, first responders, law enforcement, and intelligent officers. This typically occurs in the senior design engineering programs.

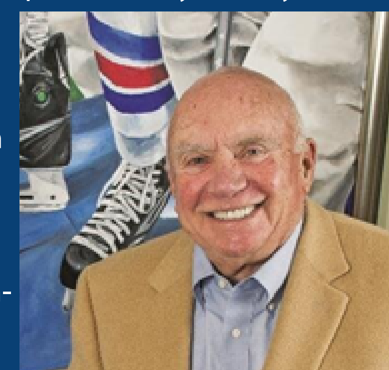
2. QL+ Clubs (or Student Associations), which started at Cal Poly, are satellite organizations of the national QL+ program where the scope is expanded into helping a wide range of local community members seeking assistive technology or medical devices. Club members range from freshmen to seniors in a variety of disciplines. Students have several opportunities through these clubs to join quarterly design projects, attend workshops, or apply for a formal design team; each offering a new way to learn outside the classroom and to help those in need.

WHAT KIND OF PROJECTS DO YOU WORK ON?

We work one-on-one with those seeking assistive technology or medical devices (called Challengers), to understand the lifestyle limitations they endure as a result of their injuries or illnesses. Leveraging our expertise in engineering, physical therapy, and program management, we identify specific obstacles in the Challenger's life that can be eased or overcome through the development of custom assistive devices or prosthetic modification.

WHAT INSPIRED THIS ORGANIZATION?

Jon Monett, former CIA Senior Executive, and US Air Force Veteran established the Quality of Life Plus (QL+) program in 2009. Inspired after viewing the feature film Fighting for Life, Mr. Monett found the documentary by Academy Award-winning director Terry Sanders and produced by Tammy Alvarez, a compelling call to action. Fighting for Life is a powerful, sobering and emotional documentary about American military medicine. Chronicling individual stories of service members as they rehabilitate from injuries sustained in combat; the film follows 21-year-old Army Specialist Crystal Davis from Iraq to Germany to Walter Reed Army Medical Center in Washington, D.C., as she overcomes the loss of her right leg in combat.



For Mr. Monett, Fighting for Life highlights that in today's wars, fewer soldiers are killed, but many more sustain serious injuries including loss of limbs. These wounded heroes need dedicated help in overcoming the daily challenges of their life-altering disabilities. Mr. Monett, using his personal expertise and resources, set out to develop engineering solutions to help these brave men and women.

Mr. Monett combined two of his lifelong passions in creating QL+: his deep expertise and professional experience creating unique engineering solutions for USG military and intelligence objectives; and his commitment to supporting his alma mater, California Polytechnic State University (Cal Poly), widely recognized as one of the nation's premier engineering universities.

The first dedicated QL+ Laboratory was dedicated in March of 2009 on the campus of Cal Poly in San Luis Obispo, CA. In this unique "Maker Space," students from multiple engineering disciplines, working under the supervision and guidance of experienced faculty, design, develop and deliver innovative technical solutions that improve the quality of life for those who have given so much for our country.

Today, Mr. Monett routinely visits QL+ laboratories and programs at major universities across the country and resides in McLean, Virginia a short distance from QL+ headquarters.

WHAT SCHOOLS ARE PARTICIPATING AND WHAT DOES IT TAKE FOR A SCHOOL TO GET RECOGNIZED?

Dedicated QL+ Laboratories or "Maker Spaces" are located on campus at Cal Poly and Colorado School of Mines. Established QL+ Programs also operate at Virginia Tech, the University of Dayton, Xavier University, Ohio University, George Mason University, Virginia Commonwealth University, the University of Conneticut, and the University of California at San Diego (UCSD). Starting in the fall of 2018, QL+ programs will operate at the University of Cincinnati, the University of Colorado, Boulder, and others.

In addition, QL+ Clubs (or Student Associations) are currently located at Cal Poly, Virginia Tech, and UCSD.

WHAT HAS BEEN ONE OF YOUR MOST SUCCESSFUL PROJECTS?

There have been many successful QL+ projects. I will mention this one because it just won Overall Design at the Virginia Tech Mechanical Engineering Expo April 27, 2018.

Push-Up Plank Device.

Dawn served as a Military Police Officer in the United States Army. She deployed to Iraq with the 3rd Infantry Division where she commanded a military police platoon in support of Operation Iraqi Freedom. In 2004, during a combat patrol near Baghdad, she was wounded, which resulted in the amputation of her right arm and right shoulder. She earned a Purple Heart and Bronze Star for her service. Despite her combat injury, she maintains an active lifestyle and trains regularly with a personal trainer. She noticed that her injury hinders her abdominal strength training. She wanted to be able to exercise her core more efficiently. She approached QL+ and requested an assistive device that would allow her to perform push-ups and support her as she does planks. QL+ student engineers from Virginia Tech designed and built a custom device to meet her needs.

WHAT KIND OF STUDENTS ARE TYPICALLY INVOLVED IN THIS ORGANIZATION?

Typically, engineering students from a variety of disciplines are involved in the national QL+ program during their senior design project.

The QL+ Club membership is open to all disciplines. In addition to engineering (which is by far the majority), there are student members majoring in a variety of programs such as kinesiology, computer science, and occupational therapy.

HOW HAS QL+ GROWN SINCE ITS BEGINNING?

The first QL+ Laboratory was dedicated in March of 2009 on the campus of Cal Poly in San Luis Obispo, CA. In this unique "Maker Space," students from multiple engineering disciplines, working under the supervision and guidance of experienced faculty, design, develop and deliver innovative technical solutions that improve the quality of life for those who have given so much for our country. In 2017, we expanded to Virginia Tech, Colorado School of Mines, the University of Dayton, Xavier University, and the University of California, San Diego.

The QL+ Student Association (club) at Cal Poly has expanded greatly into at least 150 members and includes many opportunities such as quarterly projects, lab projects, workshops, and the formal design teams. They started working with only Veterans, but then expanded into helping others in their local community. Because of the success at Cal Poly, other QL+ Clubs are starting to form across the nation.

Projects

WHAT KIND OF PROJECTS ARE BEING WORKED ON CURRENTLY?

1. National QL+ Program
2. QL+ Student Association (Club) at Cal Poly

1. Here are some national QL+ Program projects that are currently being worked on.

Soft Socket Shorties for a double above the knee amputee Army Veteran
Pushup Plank device for an arm amputee Army Veteran
Wheelchair Wheel Change device for a paralyzed Army Veteran
Blind Slalom kayak course for blind veterans
Treadmill Centering device for a blind Air Force Veteran
Manual Beach Wheelchair for a paralyzed Navy Veteran
Curb Navigation for a paralyzed Air Force Veteran
Hypersensitive Hearing for a brain injured state trooper
Handcycle Child Bike Trailer for a paralyzed Army Veteran
Snow Tubing Harness for a paralyzed Army Veteran

2. Here are some projects that the Cal Poly QL+ Student Association is finishing up this year.

Training Fin for Karen
Karen is a world class athlete with a trans-tibial amputation. She regularly competes in a variety of races including triathlons. Currently, her muscles in her residual limb do not develop evenly to her other leg when she trains for the swimming portion of her triathlons. Our challenge is to design and manufacture a swimming specific prosthesis that will assist during her training.

Trike for Sam
Sam Brenner-Ward is a 13 year-old boy who has cerebral palsy, is physically active, and loves technology. It is difficult for him to steer and reach the handlebars in his semi-recumbent three wheeled bike. Our challenge is to design and manufacture a semi recumbent three wheeler, or a bike trailer that can make it easier to steer and reach the handlebars.

Capital Stand Up Paddle Board Challenge
Capital Stand Up Paddle Board (Capital SUP) is a company based out of Annapolis, Maryland. Capital SUP provides stand up paddle boarding experiences to injured and disabled service members and veterans. Currently, Capital SUP does not have a paddle board that is conducive to users with lower-extremity weakness. Our challenge is to design an adapted stand up paddle board that assists users with standing on a paddle board.

Ankle Brace for Rita
Rita is a woman local to the San Luis Obispo area who has had multiple surgeries on her ankle following an accident. Rita benefits from the use of an ankle brace following her surgery, however the braces she has acquired dig into tender areas from her surgery causing pain and discomfort. Our challenge is to design and build a more comfortable ankle brace for Rita.

Ankle Braces for Spencer
Spencer is a Cal Poly student who has a neurological disorder which requires him to wear ankle braces during his daily life. Spencer's current braces cause him discomfort. Our challenge is to design and build slimmer, more elastic ankle braces to allow Spencer more comfort.

WHAT IS YOUR FAVORITE PART OF BEING INVOLVED IN THIS ORGANIZATION?

My favorite part of being involved in QL+ is to witness the "4 wins". The engineering students win by gaining new knowledge with a hands-on approach to learning. They also win knowing they are helping our nations' heroes lead a better life. The Challengers win by receiving technology that improves their quality of life. They also win by gaining a new purpose: playing an active and important role in the students' learning experience that can lead them to a successful career of helping others.

WOULD YOU SAY THIS ORGANIZATION FOCUSES MORE ON CASE-BY-CASE PROJECTS OR BROAD PROBLEM SOLVING?

Generally, we focus on case-by-case projects. We work one-on-one with Challengers to understand the lifestyle limitations they endure as a result of their injuries. Leveraging our expertise in engineering, physical therapy, and program management, we identify specific obstacles in the Challenger's life that can be eased or overcome through the development of custom assistive devices or prosthetic modification.

To foster and generate innovations that aid and improve the quality of life for those who have served our country.
- QL + National Program Mission

WHAT KIND OF CHALLENGERS DO YOU GET?

The National QL+ Program assists our nation's wounded veterans, active duty military, first responders, law enforcement, and intelligent officers. We recruit patriots with life-altering injuries from across the USA.

The QL+ Clubs or Student Associations help people local to their university. They may be veterans, active duty military, first responders, law enforcement, and intelligent officers.... or they can be other local adults and children with a variety of medical conditions or injuries.

A QL+ Club is coming to UMD this Fall 2018. If you would like to get involved desgining, prototyping, and collaborating to improve the quality of life for others please reach out to qlplusmd@gmail.com.

ENABLE

The E-Nable alliance is a network of professionals and volunteers who utilize 3D printing technology to produce low-cost, easy to assemble, replaceable prosthetic devices for children in underdeveloped or impoverished areas. This alliance consists of students, engineers, medical professionals, philanthropists, and everyday people who strive to "give the world a helping hand."

By: Ajay Kurian, Staff Editor

Origins of E-Nable

In 2011, Ivan Owen created a puppet hand to wear to a steampunk convention and posted a short video of it on YouTube. This led to a overseas collaboration with a carpenter named Richard from South Africa who lost his fingers in a woodworking accident. They worked through various designs and prototypes via skype. Eventually, a mother of a 5-year-old boy, Liam, in South Africa contacted them to see if they could design a miniature version for her son who was born without fingers.

Ivan did some research and discovered the Corporal Coles hand, a prosthetic design from an Australian dentist in the 1800s that was constructed via whalebone, cables, and pulleys. This went on to serve as the building block for many subsequent prosthetic devices produced by E-Nable. Additionally, he started researching 3D printing as he realized that Liam would eventually outgrow the hand. He contacted a 3D printing company and they donated two functional printers for him to produce a device.

Ivan published his designs as an open-source domain. Eventually, more and more people became interested in designing improved devices, printing existing ones, and getting involved in the community. Today, there are over 7000 members and approximately 2000 devices that have been created and gifted to individuals in over 45 countries.

Coming to UMD

Recently, students at the University of Maryland, College Park have been working to establish an official chapter here at the university. Harisha Garimella, a senior biochemistry student and current founder of E-Nable Maryland, is here to give some details on E-Nable and the work that it does.

What is your motivation in starting this chapter?

I first heard about E-Nable through a Youtube video on prosthetic devices in third world countries. I really liked the idea that anyone can help local kids in developing countries at a relatively low cost. I have always been interested in volunteer work and helping the less fortunate so joining E-Nable definitely allowed me to help those in critical need.

Can you give some detail on the value that E-Nable provides?

A few things surprised me when I read more about the issue. First of all, prosthetics devices tend to cost a lot of money- way more than local clinics or hospitals can afford. Also, I did not realize just how many people were in need of a hand. Overall, the ability to have such an impact with local 3D printing technology is one of the most incredible things that E-Nable provides.

Another thing that was really amazing was how accessible the E-Nable community is. I was able to hop onto a google conference call between several major figures in the organization and learn a lot about how it operates and the necessity for the organization. Particularly, they mentioned how India needs over 1,000 hands. That was sort of the initial spark that got me interested in getting involved and made me determined to find like-minded people here at UMD.

What has been the most surprising thing behind getting recognized and starting an organization on campus?

It can definitely be very challenging initially. Personally, what I found hardest was the justification. Getting space, 3D printers, training materials, all of it is determinant on the coordination of a lot of different people. It is not something that can be accomplished by one person or through a general body meeting. So the ability to handle and coordinate with professionals outside the university was definitely the most challenging aspect.

Another challenging aspect is finding a mentor or someone who is interested in serving as a faculty mentor. It is important to incorporate the goals of the organization to the interests of the faculty member. For example, someone in the education school may be interested in the educational aspect of 3D printing. Someone in the engineering school could be interested in designing new devices using CAD or finding out new ways to produce and optimize the prosthetic devices. Overall, you have to see what departments may be interested and, based on how you want to orient the club, find a faculty that can contribute. Otherwise time may not be invested properly.

What are some ways that students can get involved in E-nable or 3D printing in general?

In terms of getting involved in E-nable, we are open to any major. We hope to have workshops in the future where students can learn the basics of 3D printing. We recently held a workshop on assembly in a residence community as students watched the paralympics on TV. We are actually planning on having a summer camp where we will print hands for local children in the area. We tend to work with Terrapin Works over at the TAP building a lot. Additionally, there is a new prosthetics design course (ENES289P) that is offered in the university that works in tandem with the larger E-Nable community. Everyone has something they can offer E-nable and that just reinforces the idea that there are numerous ways to be involved in this organization. One of the nicest things about the community is that everything is open-source so whoever likes to design, research, or even just tinker can get involved in the community.

DR. WHITE

A Professor Perspective

Q: Can you start by telling us a little bit about your educational background and how you ended up where you are?

A: It's a bit of a long story. So, all of my training is in electrical engineering. When I was in college I wanted to work on semiconductors, when I went to graduate school I also went into an electrical engineering PhD program, and ended up not getting a position in a lab doing semiconductors and ended up doing fiber optic telecommunications; very far removed from where I am now. So all through graduate school I was working on fiber optic networks and technologies. I worked for a start-up company for a few years while I was in grad school. I guess I was lucky enough to be in grad school during the big tech boom in the early 2000's but then graduated just as the bubble burst. I did get a job in telecom, I was working for Sprint for about 3 years near San Francisco. But the industry was dead, I wasn't excited about what I was doing. I was just serving as sort an internal consultant for Sprint, a company that wasn't very dynamic at the time, just working at the interface of local fiber optic networks, kind of like FiOS is and cell networks. And so finally, I decided that just wasn't exciting or motivating so I started rethinking my whole life at that point – wanting to identify something that would make me a little more motivated to go to work everyday and solving problems that matter. So that's when I got more intrigued about doing biomedical instead of telecommunications. And then it was just a matter of trying to figure out how to start over and get into that. I knew I had skill sets in electronics, optics, things like that, so I was just looking for a way to use those skills towards biomedical applications. So, I think the two options I had were to either work in the field of imaging or to work in the filed of sensing, and ultimately found a post doc position in an optical sensors lab. So, I quit my job, moved halfway across the country, took kind of this low-paying, low-grade research job which is kind of a step down, but what I wanted to do. So that was kind of my start over to getting into bioengineering at that point. So, I had to learn chemistry, biology, molecular biology, as much as I could anyway, and kind of work my way up from there, and then actually I was lucky enough to get a faculty position here in bioengineering kind of through that retraining and starting over process.

Q: Can you a little bit more about your starting over process, when you said you had to relearn stuff, how did you go about that?

A: When I started as a post-doc, the last time I had chemistry was freshman year of college, just chem for engineers, I never took biochemistry. And the last time I had biology was sophomore year of high school, so I never had cell biology or molecular biology. So, I tried to pick up some basic books and read through them, I did a lot of google searches. As I got a little more comfortable, while I was a post doc I sat in and observed some of the molecular biology courses on campus. And found I had to actually get engaged and work through it and that helped me pick up some of the basic molecular genetics, biology, biology of the cell. So just like that and reading lots and lots of papers about techniques and you know getting familiar with the techniques in the field. I've done what I can, but my graduate students are levels above me. Again, I never had organic chemistry, I never had biochemistry, so often I find myself struggling with basic conversations and have to be very trusting of what my graduate students are trying to teach me and tell me about how a system works. So currently, I rely a lot on biochemistry, especially biochemistry of nucleic acids is something we work with a lot. But basic chemistry and organic chemistry is a daily part of what we do so I have to try to wing it as best I can, try to catch up, read through things. But as you get far removed from what your training is, you feel like you're kind of winging it all the time.

Q. Does that catch up to you at all?

A: I think it does, I definitely think it has caught up to me sometimes where I'm trying to take the group in a new direction and I want to write competitive proposals to get projects funded, and sometimes that lack of basic knowledge makes it much more difficult to come up with a robust idea. I've gotten the group into projects that didn't pan out, because there were some issues that I didn't understand, and eventually the students figure it out and educate me. So, I think we do waste a little more time than we should because my lack of knowledge, and I think it's harder to mentor the students. So anytime we have projects in optics and the students come in and talk to me about why they're struggling I know why it's not working and I go in the lab and show them "you're supposed to do it like this" But let's say a student is working on a particular project that involves nucleic acid biochemistry, when things aren't working I just say "Well I don't know why it's not working." So yeah, I think we're a lot slower than we could be because of that.

Q: Could you talk about the dynamics of your lab a little, with the varying backgrounds?

A: We actually started out a little more focused on optical sensing. Now we've really changed the philosophy of the lab over time. I guess, in our lab we try to be motivated by problems that matter. Not just by following academic trends or just trying to solve problems that seem like interesting problems. We're really trying to stay close to what we think matters. So, the kinds of ideas that we chase are especially related to disease diagnostics, and the culture of the lab we have is that we want to make diagnostics that are easier to use. The paradigm we live in today is that the majority of diagnostics have to be performed in a very specialized facility, so we give samples, the samples are sent off to specialized facilities, and anywhere from 2-7 days later we get results. Even in cases of infectious disease where we would like to get results right away, it simply doesn't fit the kind of diagnostic-right-next-to-the-patient model. So that's kind of the technical problem. I think the economic opportunity is that we see diagnostic opportunities popping up closer to the patient. For example, Walmart, CVS, Walgreens, they all have clinics now, however they're just really not authorized to run very many tests. You can go into the clinic and they can observe you and they can write prescriptions, but there are many tests they're simply can't perform. They would have to take a sample, send it off somewhere, they don't have the storage facilities for a lot of diagnostics, they don't have the training and the FDA won't allow them to do diagnostics in that environment. So, we want to take the diagnostic tests that are normally done in these specialized facilities and make them so easy to use that they can be performed inside a Walmart or a CVS or a Target. So that's the culture by which we operate, always looking for an easier solution to perform a diagnostic test, and ultimately that may mean using materials in ways they haven't been used before, using combinations of enzymes and nucleic acids to apply different ways to make a test work, coming up with automations, coming up with new ways to get from the sample to the part of the sample that we're analyzing, whatever that means. So in that sense, some of it is how we make devices, some of it how can we use polymers in a certain way, and like I said a lot of it is we want to test for nucleic acids, for infectious disease of genetics disease or something like that, but we can't do it in the traditional PCR way, so how can we invent a new way using different enzymes, different functional nucleic acids to make this thing work. Or how can we make a test for proteins look like a test for nucleic acids, using clever nucleic acid solutions. So, we don't really have a technical dogma, it's more of a philosophical dogma of whatever we can do to make diagnostic tests easier, whatever technology it involves, we're interested in. So, students can come from any backgrounds and change their interests while they're in the group. We often have students who feel they are very interested in devices or instruments, then they get involved in the group and get excited about the opportunities and begin to change their focus and become more interested in polymers and nucleic acids and end up learning a lot because of that.

Q: Kind of shifting gears, how did you get into teaching, and how did you find working with students on regular basis, given your background?

A: That also kind of helped shaped the pathway a little bit. When I was a graduate student, or even further back when I was an undergrad, I was maybe the student that would always try to assemble a group and be like 'let's try to study for this exam together' and I would always end up at the chalkboard trying to show everybody how to do that problems. I enjoyed that, I enjoyed studying that way, I enjoyed those kinds of interactions. When I was a grad student, I really enjoyed my TA-ing and I guess smore than anything the part that I really enjoyed was the one-on-one interactions with the more junior students. So, my adviser at the time kind of let me handle recruiting students into the lab, and so I would spend a lot of time interviewing first and second year grad students, showing them around the lab, teaching them how things work, kind of teaching them the philosophy, the approach. For whatever reason I just enjoyed those kinds of interactions, the mentoring opportunities, and trying to show a new uncertain student the way forward. That said, as I was graduating I was burned out, and wanted to go make some money with my engineering degree, so I said, "No I will not become a professor, I am tired of being in a university, this world owes me some money so I'm going to go make some money." And it was probably about a year being out into the industry that I started to feel like things were missing, and I had to do some soul searching to find out exactly what was. And I concluded two things that were missing: one was problems that

Interview conducted by: Subhashini Arumugam (Finance Chair) and Yutong Liang (Staff Editor) motivated me which certainly pushed me toward biomedical, because biomedical problems are so motivating to think about the problems you can solve. Making someone's internet connection cheaper, or how can we make more money off of somebody's internet connection, I just didn't care to get up in the morning to think about that. But in that same soul-searching process I realized one of the things I really missed was that kind of mentoring role, and working with students one-on-one, and showing them what I thought was a good path for them to take in the work, career, whatever. So instead of trying to look for a job in the biomedical space, that's what really pushed me into going into a university and retaining myself for the university environment. And in the opportunity I also got to mentor new grad students and undergrads, and it just felt like the right thing to do, so then I decided I definitely wanted to look for a faculty position. Yeah, I enjoy my time in the classroom, but I think more than anything, I enjoy the smaller, more focused, intimate conversations with students – whether it's about a particular topic, or whether it's about career directions, capstone groups, things like that.

Q: Can you talk about your teaching philosophy?

A: My teaching philosophy is shaped based on the experiences I had in college and then based on the experience I had when I was trying to learn molecular biology. First in college, I liked working in groups and I learned best when I was forced to try to learn the subject a little bit deeper on my own, and then try to teach it to someone. I always look for opportunities to do that whenever I can and to get students to do that.

When I tried to learn molecular biology, the class I took had the approach of giving us a paper to read, we would read it and I would go to class with the feeling that I understood it, but then the instructor would put us into groups of students and have us debate some answers to questions. Then I would realize that I didn't understand the questions as well as I thought I did. Because of the conversations between other students, you start to sort things out a little better. In addition to that, even if I had read it before class and the professor just lectured to me, I probably wouldn't have paid attention. But the instructor saying "you need to explain to these three people what you think the answer is" forced me to dig so much deeper into my brain and understand it at a deeper level. Just to take it at another step, each student in the class had to teach once during the semester. This forces you to not just look at the material and to understand it so deeply that you can convey it to other students and understand what should be emphasized. There were not that many lectures, mostly students being pushed to learn [the topic] in different ways and explain it to each other.

I've copied that style in my BIOE431 class. I assign a paper for every class period, and classrooms have tables with 6 chairs [rounds] so the students are pushed to sit in groups of 6. They are given a paper, which they should have read beforehand, and discussion questions. I randomly assign the questions to the tables and then they talk about it as a group. One person from each table submits their answers for that day. The peer pressure from sitting down and talking with others forces students to be more engaged than me lecturing. I only lecture about 10 minutes a day in class, the rest is up to the discussion format. First the students discuss the questions, then I take over the class about halfway through and we go over the questions. Each table will try to provide an answer, and then I'll echo the answer and try to talk more deeply about it. I'm convinced that the idea of trying to teach it to yourself and having to talk about the topic allows a much more deeper understanding of the material. From my experiences, every time I've been in a lecture class, I can learn it for that day, and I can forget it, and then study for it for the exam, take the exam, and 24 hours later its gone. But when I have to engage with somebody and talk about, I remember it then. My philosophy is not having the students just listen to me whenever possible, but getting them to learn by talking about things and feeling more independently responsible for learning the material on their own. Having students teach themselves and having them teach each other works better.

I haven't quite figured out how to implement this in my BIOE457 instrumentation class. For the 50-minute class, I try to lecture for about 30 minutes, then I have 10 minutes for everybody to get into groups and assign a couple of example problems and have them work through the questions. I give a quiz at the end of every class, and the quiz usually looks like the example problems, but it tries to get the students to pay attention and not just look over their notes before the exam. There were times where how I learned was by organizing small study groups and ending up teaching that study group. That's why I try to get the students to work through the examples in small groups during class, and I give the quiz to force them to reflect on what they just practiced. But I wish if I could to cut down the lectures even more to get the students engaged more. In one year, one of the comments I got was that I should write down on the board every word I say, because some students couldn't remember what I was talking about when they were studying for the exam. The philosophy is not for the students to write down everything that I say, but to get them engaged and teaching themselves the material when possible.

Q: What topics do you cover in BIOE431?

A: It's really aimed at molecular diagnostics, specifically on how we can use proteins and nucleic acid sequences that are in our blood, tissue, etc. to answer a question about our health status. The most common things that come up are using nucleic acids for infectious disease diagnostics or using either the previous method or protein biomarkers for cancer diagnostics. In the diagnostics world, these two are the more common methods and diseases that people think about the most. They generally apply to the idea of instead of applying a differential diagnosis on a patient by observing symptoms and figuring out what's wrong and make a guess, instead we could take a sample and analyze the molecular components to make a more informed guess of the patient's health state. First, we set up the "gold standard" and how the field is doing this already, then we move on to the more recent technological advances that may allow us to improve upon these "gold standards". Towards the end of the class, we start to emphasize two things. One is new emerged commercial products and we compare them to where research has gone. An example would be point and care diagnostics, which my lab is interested in. We talk about the regulatory impacts, implications, and what technologies are necessary and need to be developed. Basically, it is a survey of recent technologies and how we can do diagnostics using molecular signatures.

> AS SOPHOMORES, THERE IS A LOT OF VALUE IN TRYING TO IDENTIFY WHO YOU WANT TO BE AFTER GRADUATION.

Q: Do you have any advice for BIOE students in the department, such as pursuing academic and extracurricular goals?

A: As sophomores, there is a lot of value in trying to identify who you want to be after graduation. We specifically set up BIOE221 to try to do this, and we try to improve upon this every year. I think the earlier the students can identify if they want to go to graduate school, medical school, or get a job, the better. If they want to get a job, what area are they interested in? I think students can be much better positioned by knowing this. We want students to collect the skill sets that they need in their junior and senior year. What we see a lot is graduating seniors saying "wish I would have…. worked in a lab… or taken these electives or learned more about programming…" We graduate a lot of great students, but they were just "soul-searching" a little later than we wish they would have been. The biggest thing to me is if students can make these decisions as sophomores and map out the skills collections for junior and senior year. The tracks serve as this and help students shape their resume, as well as compliment the capstone project. For students who want to go to graduate or medical school, the key goal should be to get into a lab and get the experience and be as independent as possible. For students who want to get a job, the key is collect a set of skills, whether that's programming or CAD, and then having the capstone project align well with your set of skills. People who are interviewing want to see the right skill set, as well as an independent problem-solving attitude of using those skill sets. The types of questions people ask at job interviews are more open ended, such as telling about a time you solved a problem that required troubleshooting, telling about a time you had to lead a team out of a challenging situation, thinking outside of the box. Capstone is set up to give you all of those answers, and by lining up capstone with your track, you can talk about how you use your skillsets to accomplish all of these problems. All of this should start in the sophomore year and we try to get students ready through BIOE221 to shape themselves for graduation.

Q: Could you talk about capstone, such as how to pick projects and how it works overall?

A: Capstone is a year-long project with a group of five students. I run through a checklist with my team when I meet them during the fall of the things I want to see. Number 1 is picking the project, and it is important to pick a project that is aligned with your skill set and will allow you to develop your goals, such as getting a job. It shouldn't be too easy that you wouldn't be able to develop any good stories and experiences, but it shouldn't be such an overwhelmingly challenging project that the group won't make any progress. This whole year should be about your goals and how to make your capstone experience fit these goals.

The other thing I try to help with is group dynamics. Everyone in the capstone group should get a leadership role and experience at some point. Companies and graduate schools want to hear a story about how you have been a leader. I tell my capstone teams that I don't want student X to be the team leader, I want you all to come up with five divisions of this project and I want each of you to be a leader, such as being the VP of clinical, design, regulatory, research, etc.

If they are interviewing and ask for a time you were a leader, then you will have a story about when you were leader of different tasks.

DRY LAB DR. MONTAS

By: Maxwell Hakun, Outreach Coordinator

The story of how Dr. Montas became the scientist that he is today is one which starts from the very naissance of his childhood. From when he was relatively young, where others imagined being Superman in the Saturday morning cartoons, Dr. Montas was drawn to the characters of doctors and mad scientists. Thus, when the time came for Dr. Montas to pursue a higher education, it was only natural for him to attempt to follow in the footsteps of the sci-fi scientists of his youth. At the time, the idea of mixing engineering and medicine had recently been jump started by some recent breakthroughs in the fields of not only medicine, but also ecology. After tinkering with Electrical Engineering where some of his electronics blew up on him, he was drawn to biological engineering as a way to improve people's lives by attempting to improve agriculture through engineering principles.

Academia was the natural progression for Dr. Montas as he was drawn to the freedom it presented. Whereas in an industry job you may need to wear a suit and work 9-5, in academia, you are given the freedom to work on your own schedule and work on a project limited only by your ambition and technical imagination. In regard to why Dr. Montas chose to focus on the computational aspects of bioengineering, like so many people, your passion springs first from your opportunities. After working with his mentor on a computational senior project, he stayed on for his graduate study in the same field. This blossomed into his current interests of using partial differential equation models.

The current work Dr. Montas is performing in his lab revolves around his Diagnostic Decision Support System. The idea is to be able to model various types of biological agents and develop various tools and strategies to develop control plans for these biological agents. His work has focused on both factors that influence plant growth in outside environments and also studies into aquatic habitats and the sediment and nutrient pollution from areas surrounding these bodies of water. Both of these factors feed into the overarching concept of global warming and the goal of analyzing the changes to our current climate statistics in order develop the redesigns of our infrastructure to counteract and evolve with these statistical changes for factors such as food production. Some work he plans to expand to in the future is developing more collaborative proposals with a collection of investigators from various universities in the Mid-Atlantic or Northeast to gather not only various regional perspectives on the differing effects of climate change, but also take advantage of various specializations such as climate, ecology, hydrology, or computation to develop a more holistic analysis.

Computational Vs. Wet:

In regard to the distinction between a computational lab such as the one Dr. Montas runs and a more traditional "wet" lab, the basic distinction comes down to the results that one gets. The computational lab is often more abstract as you attempt to represent what is happening through models to better understand how reality works. Whereas a wet lab entails designing and performing an experiment, determining it's repeatability, and drawing conclusions from the data collected. A computational lab comprises attempting to replicate what is observed in an experiment using mathematical concepts and models. As Dr. Montas says, "Both approaches are necessary since as long as we know nothing about something, we could put an abstract model together but never be able to test it, just like we could do some experiments and perform some statistics but never be able to advance our understanding of the underlying processes that are occurring to make it behave in the way that it does." There is a niche for everyone as some people excel at the lab work but are limited in there understanding of the depth of analysis they can perform whereas others are clumsy when they perform lab work but have a strong grasp of the deeper numerical and modelling concepts. The key is to find others whose strength is your weakness and vice versa and collaborate with them.

In regard to the benefits of working in a computational lab, whilst it may take some time, computational work can give you a better understanding and ability to conceptualize a problem. This is something that someone must nurture and build upon as your exposure increases. In regard to the career opportunities for someone interested in a computational lab, besides academia, there are major job opportunities working for the government on data management with the goal of analyzing situations and identifying potential responses. Insurance companies are also a key field for biological computation as they need precise models to ensure they can maintain a stable business with the proper premiums to prevent them from going out of business. Any business that requires risk analysis is a prime field for computational analysis was our technology increases. Going along with this, as our technology increases, and medicine becomes more personalized, there will be a greater demand for people who can create systematic models to predict our medical needs and prescribe the proper treatment.

With respect to the way a computational lab functions, normally you will rely the databases or the previous work of an experimental lab. In cases where the data does not exist, it is crucial to possess the skill to be able to establish collaborations who will supply you with some data acquisition and experimental findings. From here, the computational people can build their models and work in a symbiotic way to provide the experimental lab with a more complex understanding.

For a final note, as our computational capacity has become exponentially smaller and faster, the future of computational biology is building towards personalized monitors and computers in our bloodstream. Even now, the size of a central processing unit (CPU) is not much bigger than a blood cell. What's to say that in the future we won't have little computers powered by the glucose in our blood and carrying out some simple tasks until they've served their purpose. We've gone from having computer rooms to personal computers to having a computer in our pocket and on our wrist. From here, computational labs are performing the work necessary to continue this natural progression to having computers located inside of our bodies.

WET LAB
DR. JAY

By: Aviva Boroson, Staff Editor

Dr. Steven Jay stumbled into bioengineering in much the same way I did: by chance. While he had not initially intended to study engineering, and planned to pursue the pre-med route, he changed his mind after receiving an intriguing flyer about a biological engineering program. Since switching from traditional biology to bioengineering seemed like a more difficult transition, he decided to begin with engineering and ultimately stuck with it. After some time in the lab conducting experimental research, he also decided to forgo medical school and pursue a career in academia.

The best part of his job, he says, is the self-determination. "I like that if I have an idea I can pursue it, without needing to check with someone else. There is a tremendous amount of intellectual freedom which very few jobs allow."

While his undergraduate and PhD work focused primarily on drug delivery vehicles, he noticed that translation of that field into products and treatments was slower than he wanted. For his postdoctoral research he switched gears, working more with fundamental biology. When he started his career he decided to merge the two backgrounds, utilizing biological components while implementing engineering design to create therapeutics.

Currently his lab focuses on technology development, letting the projects and clinical applications evolve organically. His group has three main areas of focus: They design protein-based therapies, work with extracellular vesicles, and develop methods to translate drug delivery mechanisms into large scale bio-production. In regards to extracellular vesicles, they are trying to increase and specify the vesicle cargo contents to increase potency as therapeutic vectors. This segues into the third focus of the lab which involves learning how to produce the vesicles uniformly, at a large scale, and with better manufacturing properties so that eventually the process can be used for mainstream targeted drug therapies. Within these three concentrations, Dr. Jay's lab has a variety of projects. They are working on improving vesicle potency for treating non-healing wounds for diabetes and burn victims, large scale production for cardiovascular disease applications, and collaborations which study spinal cord injuries, sepsis, and osteoarthritis.

Wet v. Dry Lab

While Dr. Jay's lab is purely a "wet lab," he reflected that the major difference in lab style is whether you prioritize physical experiments or work primarily with "in-silico" simulations. Computational simulation work requires an independent, self-driven work ethic because it can essentially be done anywhere at any time. Complex simulations can be constrained by time since they take a long time to compute, however, he speculates that "in-silico" work retains a greater proportionality: the work you put in directly correlates to the results you get out. In contrast, physical experiments require time to set up and often produce flawed or unexpected results, necessitating additional trials. Additionally, wet lab experimentation involves a certain degree of lag time, particularly when working with bacteria or mammalian cells since they need time to grow. Furthermore, if you are trying to induce an effect it might take several days to manifest.

For students who are conflicted about which lab experience to pursue, both kinds are instructive and translatable. "If you want to work hands-on in the biotech industry, the pharmaceutical industry, or bio-manufacturing, that's when my lab or any other wet lab might be the best choice. A wet lab would help prepare students for jobs that require development of a physical product, or where you have to actually do that physical experimentation." For students who feel more inclined towards computation, "There are definitely other jobs within those same industries that would require knowledge of simulation, computational design, or programming, and a computational lab would be a great place to gain that experience. Biotech and pharmaceutical companies have a variety of roles to fill. While computational design and modeling would be more upstream in the design phase, wet lab work is necessary downstream in the implementation phase."

While bioengineering labs can often be categorized as one lab style or the other, the field can incorporate elements of both. "We tend to integrate computational tools minimally, but we do some design and modeling to understand how proteins would interact with receptors. This enables us to see if we can design inhibitors that optimize molecular interactions. We also use CAD to design some scaffolds for cells and flow modeling to understand shear stress rates or how oxygen concentrations relate to scaffold geometry. So we definitely utilize computational tools, but we are not interested in designing those tools." In Dr. Jay's opinion, bioengineering is partly about the combination of skills and knowledge, but it's more about the attitude of the research. "Pure biology research attempts to answer the question 'how does this work,' while bioengineering research generally involves creating a solution to a problem. And that's the engineering mentality in general: You find a problem and try to fix it."

Where are they now?

Luke Peterken

Luke Peterken graduated May 2014 from the University of Maryland with a degree in Bioengineering. While at UMD, Luke served as president and events chair for BMES, and was part of Student Government Association, Engineers Without Borders, Marching Band, Club Swim, and Water Polo Team. Additionally, he was part of the founding board for The Catalyst, and was involved with Startup Shell where he worked on his startup focused on MRIs.

Interview Conducted by : Havisha Garimella, Staff Editor

Q: What do you think helped you get to where you are now?

A: "Classes in hindsight… classes like imaging and statistics have a lot of real world application. But more importantly, I supplemented my knowledge with additional classes and experiences that gave me in-depth knowledge of BioE and MechE skills, which is important for some careers (i.e. systems engineering or more mechanically focused product design). The BioE degree gives you a broad understanding, but it's up to the students to get a deeper understanding by taking additional classes or working in different types of labs. 75% of the knowledge can be gained by the degree and the remaining 25% is up to the students. The difference between an ordinary engineer and an extraordinary engineer is that last 25%."

> *College is one of the best opportunities you have to be exposed to the widest range of world views, it would be silly not to take advantage of that.*

Q: What's your view on academia vs. industry?

A: "A startup on the side gives you great experience for business; it's the perfect hybrid of academia and industry. You learn how your company fits into the landscape of biotech and how it stands up against competitors. Industry is sometimes slightly behind cutting edge technology, but you get to create products that are used by thousands and can change thousands of patients lives. Academia on the other hand is where the real cutting edge research and technology is found, but the path to seeing a real-world application can be longer."

Q: What do you do now?

A: "Right now I work at Lonza as the lead engineer for the R&D autologous cell therapy engineering group. My group focuses heavily on engineering novel methods of cell therapy manufacturing. Prior to this, I worked at Meso Scale Diagnostics which is a company that produces diagnostic kits for various biomarkers. I worked in the manufacturing and operations department where I focused on automating the manufacturing process so that we could go from a concept on paper to making one million 'concepts' a year."

> *Don't lose sight of other opportunities that help you get a world view.*

Q: What do you enjoy about what you do?

A: "At Meso Scale Diagnostics I could wear different hats because it was a smaller company. The company gave me a lot of opportunities that bridged R&D and manufacturing. With my role, there was a lot of overlap between biological engineering, mechanical engineering, and business development. As a bioengineer I feel that we fill a niche to be at the intersection of biology and engineering. In my positon at MSD I would be negotiating with vendors, meeting with executives, travelling offsite to collaborate with outside companies, and working with manufacturing to streamline automation. It's important that BioEs aren't afraid to go into a field that challenge us as engineers; those kinds of jobs help you grow."

Q: What advice do you have for bioengineering undergraduates who want to go into the same field?

A: "Don't lose sight of other opportunities that help you get a world view. Make connections in college; don't forget about that last 25%. Take more time to do weird clubs that don't connect with your degree so that you can get a different view of the world by meeting different people you normally wouldn't meet in your major. "

Q: If you could change one thing in your undergraduate path, what would it be and why?

A: "I would spend less time studying. I realized later in my college education that it's useful to get exposed to more opportunities, research experiences, and meet new people. I used to study a lot during my first two years in college and of course studying and classes are important, but I later realized it's not the only important thing. It's important to make time to go make connections with other people in addition to studying."

Q: What did you enjoy about The Catalyst? Did you find yourself utilizing any of the skills you've gained from The Catalyst after graduating?

A: "I was there with The Catalyst early on. We were starting the organization because there was a lack of newsletter in BioE, so it was nice to have a paper that everyone could connect with and call our own. It taught me what a starting organization should provide; what niche to fill."

WHERE ARE THEY NOW?

Kevin Pineault

Interview Conducted by : Havisha Garimella, Staff Editor

Q: What do you do now?

A: "Currently I am a second year medical student at the Johns Hopkins School of Medicine. We started clerkships this past March, so I am rotating on the internal medicine and surgery services for the next couple months in Johns Hopkins Hospital. Outside of coursework, I conduct clinical research in the Vestibular Neurotology Lab (PI: Yuri Agrawal) and Facial Reconstructive Surgery Lab (PI: Amir Dorafshar). I also spend time volunteering at a local homeless shelter's medical clinic, the Baltimore Rescue Mission, and doing eye screenings in Baltimore through Student Sight Savers."

Q: If you could change one thing about your undergraduate path, what would it be and why?

A: "From the day I transferred to the University of Maryland from a small community college in Delaware to the day of graduation, I had an incredibly rewarding experience in the BIOE department. However, I wish I had gone outside of campus more often. It is wonderful working with faculty on campus, but I think it would have been interesting to reach out to local startups or physicians at Johns Hopkins Hospital or the University of Maryland Medical Center and collaborate on clinical trials, device development or software engineering. These are all very powerful skills whether you want to be engineer or treat patients. Looking back, I also wished I had taught other students more often, either as a Teaching Assistant or as a tutor leading sessions for engineering and biology courses. Additionally, I would have spent more time reading journals, listening to NPR and podcasts, or just reading more literature… honestly anything besides class materials. And like everyone, who doesn't wish they had traveled more outside the country?"

"In addition to finding a great mentor, everyone should also be a mentor in some capacity to other students as well."

Q: What advice do you have for bioengineering undergraduates who want to go into the same field?

A: "Having a great mentor (or two or three!) is critical to success as an undergraduate. I believe everyone should not only have a mentor to schedule classes or discuss career planning with, but also a mentor whom accepts you as part of their team. Someone you can work with who will offer ideas, understand mistakes you make, and challenge you to come up with your own ideas to contribute. You don't have to be doing research in a lab to receive great faculty mentorship, and the discussion does not have to be about research either. I personally think everyone should think about what they really value and want to get out of their degree, such as do you want to present at a conference or create a device prototype outside of class. If you realize something doesn't feel right for you, whether it be a laboratory position or club, I encourage you to stop and pursue what you really care about; what you actually don't mind attending meetings for.
In addition to finding a great mentor, everyone should also be a mentor in some capacity to other students as well. My most valuable experiences and periods of personal growth at UMD involved mentoring other students in class and at extracurricular club meetings. If your work outside of class and your mentorship truly reflects what you value, you will stand out when you graduate!"

Kevin Pineault graduated from the University of Maryland in Bioengineering in Spring 2016. During his time at UMD, Kevin was an undergraduate researcher in Dr. Jewell's Immune Engineering Lab, and was part of Tau Beta Pi, Student Government Association's Health and Wellness Committee, and Pre-Medical Society. In addition to being a Clark School Ambassador and Resident Assistant, he was one of the founders of The Catalyst.

Q: Looking back, what did you enjoy about The Catalyst? Do you find yourself utilizing any of the skills you've gained from The Catalyst now?

A: "During creation of the first issue, I enjoyed the collaborative atmosphere The Catalyst board quickly endorsed. Collectively, we realized within the first month that an undergraduate research journal needed to be a shared vision among members in order for it to develop and adapt each semester to the rapidly growing BIOE department. Working on The Catalyst issues changed my perspective of what it meant to be a leader and what it takes to have a novel student-led organization actually survive longer than a couple semesters. I realized all members need to feel personally connected to and invested in The Catalyst's mission of encouraging undergraduate research and discovery. When I was the editor, I devoted time to learning about members' talents, whether it be editing on Adobe InDesign or interviewing faculty, and made sure everyone was using their best individual talents so that collectively we could create a stunning issue with equal contribution from everyone. Everyone felt valued and that they had purpose. I still use this approach of familiarizing myself with everyone's talents on clerkships as we assist doctors with treating patients with a variety of conditions and during my research leading a team of fellow students to answer clinical questions."

Q: What do you think helped you get to where you are now?

A: "My time spent in Dr. Jewell's lab doing research helped clarify how I want to use my mind each day on the job throughout my career. I realized that I valued the excitement that comes with contributing to medicine with good ideas. I would rather be a lifelong learner conducting research in addition to practicing medicine than just be a clinician who does the same set of procedures each day. My experience with leading The Catalyst and Pre-Medical Society provoked my desire to educate and motivate people that I will be working with as a medical team. With regards to getting into a respected medical school, it is certainly due to factors most students are already aware of, including good grades, leadership in extracurricular activities, valuable community service and fruitful academic research (potentially a paper or presentation by the time you submit your AMCAS application). For these basic requirements, go talk to an advisor at the Reed-Yorke Health Professions Advising Office ASAP even if you're a freshman. During my own application process, I realized that the best medical schools were the most holistic. They were interested not only in grades, extracurricular and service, but my personal growth and maturing values related to compassion and service."

During creation of the first issue, I enjoyed the collaborative atmosphere The Catalyst board quickly endorsed.

GRAD SCHOOL

A look into the future with Milos Nikolic | Interview by Maryam Ghaderi, Staff Editor

WHAT IS YOUR RESEARCH ON?

I work with the Scarcelli group and we work on a variety of optical techniques with applications in biology. I mostly work with Brillouin microscopy, which is an optical method to detect stiffness without contact to the samples. I work on measuring stiffness of cancer cells and how they behave in different environments. Specifically breast cancer. There's been a lot of research in the past years that show that mechanics of cells is very important. One example is when cells metastasize and invade organs they do change their mechanical properties, they soften up, so they are able to squeeze through smaller spaces and invade better. That's just one example, there's a lot that we need to understand about how human cells interact with their environment mechanically and how it interplays with biological and chemical changes inside the cell and how that is relevant for diseases.

HOW COMPETITIVE IS IT TO APPLY AND GET ADMITTED TO GRAD SCHOOL?

I think that if you know what you're doing and if you have your mind set on it, you have a really good chance of getting in. I never felt that getting into grad school was competitive or low chances. The only thing is where you want to get into. I remember in my undergrad when I was applying my peers were stressed about schools that they're applying to but ideally in the end research is all unique everywhere and so it kinda makes it the same everywhere so wherever you go you're able to do something original and collaborate with really great people.

IS IT COMPETITIVE BEING IN GRAD SCHOOL?

I don't feel competitiveness inside the department. Everyone's really helpful and friendly. But in the real world, you're competing not only against other students but other scientists for funding. So depending on your field it may be competitive. I'm very optimistic about this, since you can always find something to do.

WHY DID YOU CHOOSE UMD AND THE SCARCELLI LAB?

Maryland is a really good school and it's not too small for me. Size was one of the criteria for me when I applied to grad schools. I did my undergrad in a small institution. I came to UMD because it's bigger and geographically in the center of things. There are plenty of opportunities. Since it's close to many other big research institutions you get to meet people who are doing really cool science and you get to collaborate with them. Maryland has reasonably good funding for science, too. During my first year when I was rotating between different labs the lab of Dr. Scarcelli seemed to be the most exciting to me because we have this new microscopy technique that we're trying to make work. And at the same time we're trying to apply it. It's going to give me an opportunity to build my career on two pillars. I can tell people I'm a good microscopist if I do a good Ph.D. and I can say I figured something out on the biological side by using it.

BIOBYTES

Universtiy of Maryland's First Bionengineering Hackathon

By : Loren Suite, Editor-in-Chief

University of Maryland's first annual Bioengineering-themed hackathon, Biobytes, made its debut on February 17, 2018 at the Computer Science Instructional Center on campus. This hackathon was developed by the Bioengineering Honors Society at UMD, Alpha Eta Mu Beta. This 24-hour hackathon brought together 60 students of all majors and skill levels, challenging them with the task of improving or developing a device, app, or solution with the goal of improving the life of someone who is physically disabled. The specific theme of this year's hackathon was instrumentation intervention for physical disabilities. This disability could come in any form. Hackers chose a range of disabilities to focus on, including color blindness and depression. Workshops were provided during the hackathon to help students develop key skills such as coding an Amazon Alexa and 3-D printing with Terrapin Works to be used during the hackathon. Mentors and judges were consistently present throughout the 24-hour period to provide guidance and to participate in workshops as hackers organized into teams to hack for prizes such as Amazon Fire Tablets, Amazon Echo Dots, and Tile Trackers. The winners of this years competition was David Boegner, Nadiya Klymenko, Christopher Look, and Anoop Patel who designed LinkUs to allow guardians to keep track of young children while visually impaired.

Biobytes Winning Team: LinkUs

Fueled by Insomnia cookies and a love for bioengineering, students were challenged with developing a solution for this years hackathon. Have you ever wondered what it it's like to be behind the scenes of a Hackathon or what resources are needed to bring a Bioengineering-themed hackathon to campus?

I interviewed the Director of Biobytes, Jessica Yau to gain insight into what it's like to see the idea of such a hackathon turn into a reality. Jessica is a recently graduated Pre-Med Bioengineer who is on the M.D./Ph.D. track. Yau was inspired to bring the hackathon community to BIOE and develop a hackathon that integrates specific skills that BIOE's use in classes such as 3D printing. She wanted to give UMD students an opportunity to apply their major skills to a real world problem.

Jessica Yau (bottom row, middle) and board members

Yau had the aid of 12 other hackathon board members with specific positions to figure out logistics such as scheduling, securing mentors, and finding judges for the event. Other areas of importance included advertising to participants, establishing security for people working overnight, getting hardware for the hackers to use, and funding. Major League Hacking became a local host of the hackathon and Bitcamp was able to donate some hardware for use. Yau argued that the most difficult part of coordinating was funding and that coordinating an event of this scale is "like planning a wedding". Yau took pride in meeting others in the BIOE community and encouraging students to pursue their projects while uniting to solve problems during the hackathon. It is her hope that Biobytes lives on as a campus tradition for anyone with an interest in bio-inspired hacking. Biobytes may be new, but it is a strong force in the hacking world.

A Bioengineer's Guide to University and Beyond

By: Michael Hildreth, Marketing Chair

If you're reading this, you're probably like me: a bioengineer who feels somewhat lost in this hodgepodge called college. It's difficult to understand what exactly bioengineers do, and what path to choose within the major to land that first job. I sought out the help of Abby Shantzis, an Academic Coordinator within the department, and Catherine Donohoe, a Career Advisor on campus, to compile the following tips to navigate the bioengineering major, and eventually find a job.

UTILIZE YOUR RESOURCES! When first starting out as bioengineers, learning how to navigate the major can be a taxing endeavor. Fear not! there are many resources at your disposal.

1. **Self Reflection.** Without considering your own goals and interests, these endeavors will only serve to waste your time.
2. **Friends Know Things Too.** Fellow bioengineers, upperclassmen, people in your classes all have experiences to share and can lead you to specific resources, give recommendations for future classes, and recount some of their own professional experience.
3. **Professors Love to Talk.** Some of the most under-utilized resources on campus students are faculty members. Go to office hours. Faculty have a plethora of knowledge of their own research and can lead you to others who may know about what you are interested in. In addition, emailing a track leader can help you to understand more about specific tracks and the jobs that utilize that specialty.
4. **LinkedIn Is Your Friend.** As Abby describes it, "The Maryland Alumni page is a great place to find a lot of different data points, of different people, who are doing a lot of different things, based off of what you are interested in." his service provides "an unfiltered ability" to learn from UMD alumni, and specifically search for career paths you are interested in. Terrapins Connect is a portal where you can connect with potential mentors around the world.

GET INVOLVED! BMES and AEMB host various networking events where you can learn, network, and develop professional skills while understanding the opportunities available.

1. **Within Industry There Are Options!** Bioengineers constantly are told about "industry" but what does that really mean?
2. **Industry is Broader Than You Know.** Talking with Ms. Donohoe, the term merely represents employment options in general. "It's a changing and growing area so it's difficult to define what a bioengineer does". She mentions "tech consulting, bioinformatics, patient care, pharmaceutical companies, drug delivery, and entrepreneurship" as just some of the focal areas alumni work in. There are plenty of options for bioengineers in private industry and government; it's more a matter of understanding your own interests and skills.
3. **You Have Options.** Organizations that hire bioengineering majors, which are as diverse as Accenture, National Institute of Health, Appian or AstraZeneca, offer positions in consulting, project management, supply chain management, product design, technical sales, research or software development.
4. **Understand Your Goals.** Depending on your long term career goals, you might need to plan for graduate study, whether a Ph.D., an M.D., M.S., M.B.A. or M.P.H.

HOW DO I GET A JOB? HOW DO I KNOW IT'S WHAT I WANT? There are many opportunities you can take advantage of as an undergraduate to increase your chances of having a full time job lined up before you graduate. Starting your freshman year, read emails from the department and Engineering Career Services, use Careers4Engineers and other online job boards for bioengineers. Take advantage of workshops and services to prepare your resume, cover letters, and interviews.

1. **Research and Volunteering.** Gain experience on campus. Talk to faculty about opportunities to work in a lab on campus, or see options at ugresearch.umd.edu. Beyond Maryland, Summer Research Experiences for Undergraduates (REU's) open applications as early as November, so search for these through Careers4Engineers, the BIG Ten Academic Alliance, and nsf.org. Contact the program coordinator for questions, and reach out to professors to express interest in their research. Consider applying for Alternative Break programs that address public health, food safety, or other issues related to bioengineering.
3. **Internships and Co-Ops.** There are peak hiring seasons (September-October and January-March), when the greatest number of employers visit campus for fairs and information sessions, but internship and co-op job opportunities are posted on a rolling basis. Private companies, government agencies, and other organizations may post opportunities anytime between August and April. While many companies look for Juniors or Seniors, underclassmen should plan to attend the career fairs and networking events open to bioengineering students to meet with recruiters in person.
4. **Informational Interviews.** In Ms. Donohoe's experience, learning how to network effectively is the best job search strategy. Through your own personal network or portals like Terrapins Connect, you can set up a meeting to learn more about a professional's career path and day to day life in their workplace, without directly asking for a job or referral. This is different than a job interview. Your goal is to learn more about a company or possible career path by asking questions that are not on the organization's website. Done well, networking can help you stand out in the job application process and maybe lead to opportunities you had not considered.

Overall, it is important as undergraduates of any year to include career activities in your schedule, and seek out opportunities to build skills and connections beyond the classroom. Hopefully, this variety of tips will enable you to further explore the opportunities around you in order to greater understand the internships, co-ops, and full time jobs that you could obtain.

Student Research:

NIKITA KEDIA
NIALL COPE

A first-hand look into the innovative technologies University of Maryland Bioengineering students are developing, inspiring, and collaborating on.

NIKITA KEDIA

FDA ORISE Fellowship

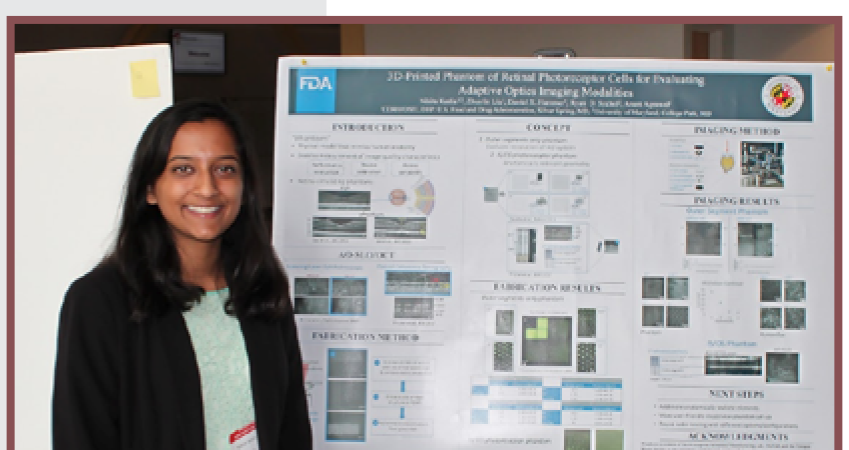
My name is Nikita Kedia and I'm a rising senior in the bioengineering department on the pre-health track. For the past year, I have been working as an ORISE fellow at the Food and Drug Administration in in their Center for Devices and Radiological Health. I work in the Division of Biomedical Physics in a lab which focuses on research involving different optical imaging techniques.

My project, under the mentorship of Dr. Anant Agrawal, is to fabricate a phantom for a novel high resolution optical imaging device. Phantoms are physical models that mimic human anatomy and/or enable measurement of image quality characteristics. These phantoms have been used for performance evaluation, device calibration, and assessment of inter- and intra-device variability in both clinical and preclinical development for a variety of different imaging modalities, including X-ray, CT, MRI, and ultrasound.

My work focuses on making a phantom for adaptive optics-enabled optical coherence tomography (AO-OCT) and scanning laser ophthalmoscopy (AO-SLO). Currently, the most commonly used clinical device by ophthalmologists is optical coherence tomography (OCT) which is able to diagnose retinal diseases such as macular degeneration and diabetic retinopathy. However, OCT has a limited resolution. With the development of adaptive optics, which uses wavefront sensing and compensation to detect and correct for ocular aberration, imaging modalities such as OCT and SLO devices are now able to resolve individual photoreceptors and other retinal cells in three dimensions. This cellular level resolution can provide more information for diagnosing retinal diseases in the future.

Despite its increased resolution, this imaging modality is still not clinically available and this is in-part due to difficulties in regulating the device which is why phantom-based evaluation of the system is important. Although retinal phantoms for OCT have been created in the past, photoreceptor phantoms have been difficult to manufacture due to their micron-scaled features. By using a nanoscale 3D printer, the Nanoscribe, available in the Terrapin Works facility at UMD, we are able to fabricated three-dimensional photoreceptor phantoms modeled on the foveal cones of the retina.

The Nanoscribe allows us to create structures with micron and sub-micron scale features with high resolution. In the past, I have also used this 3D printer for a project in Dr. Ryan Sochol's Bioinspired Advanced Manufacturing Lab (BAM Lab) to create a micropost array to study the effects of substrate rigidity on cell migration. The work in Dr. Sochol's lab is what motivated the photoreceptor phantom project at the FDA.
Over the past year, I have been able to create two distinct photoreceptor phantoms: one that can be used as a resolution test for the AO-OCT/SLO system and one that mimics the anatomical structures of photoreceptor cells. Last winter, I had the opportunity to present this work at the SPIE conference and wrote a proceedings article that goes into more detail about these two phantoms.



Overall, I've recently enjoyed the opportunity to work in the lab at the FDA and am learning more about different optical imaging techniques.

NIALL COPE

BAM LAB: Kidney-on-a-Chip

I am a rising junior Bioengineering major, minoring in Nanoscience and Technology, and I am on the Biomedical Instrumentation track. This past year, I began working in Dr. Ryan Sochol's Bioinspired Advanced Manufacturing Lab, known to its members as the BAMLAB, to begin what I hope will be a three-year research experience on campus. I joined two groups in the lab to better equip myself with the knowledge and experience to launch my own project, as well as expose myself to different scenarios and attain a wide range of skills.

The first group that I became a part of was the Kidney-on-a-Chip research team. As a group of undergraduates, we were curious about the high occurrence of drug failure in the kidney (renal) stages at later phases of the drug pipeline as well as the efficacy of current "models" for the kidney. Most models for the kidney are two-dimensional, and nonporous, which does not match with the three-dimensional, helical, porous structures present in real kidneys. To see if this difference in geometry played a role in past drug failures, our group decided upon tackling the situation with the 3D printing tools available to us through the lab. Our devices would include a helical, tubular structure built from multiple rings and utilize the property of suspended microfluidics, which would allow for fluid to pass through the tube without pouring out of the openings in the tube, allowing the tube to mimic some of the torsional strain and porous behavior of the kidney tubules.

Since the spring semester began, I was primarily tasked with the design of the devices. To begin with, we needed to make sure that straight structures were feasible to design and iterate, since this could act as a stepping stone to the helical structures that we would eventually like to emulate. This work re-introduced me to computer assisted design (CAD) software and allowed me to develop the devices with input from veteran members of our group, while also granting me the chance to put my own spin on the concept. Moving from a conceptual stage of the project to physically making the device was a challenge at first, but it was one that delivered much satisfaction once completed. We printed all of our devices using the Objet500 3D printer, and conducted thorough testing using the Fluigent, which is a powerful tool used in microfluidics research that I was able to learn and utilize frequently. The devices we designed appear to be functioning desirably, so with the next school year approaching, we will hopefully be able to implement a helical design, seed them with cells, and conduct further research as to how these devices may act as a new and improved model for the kidneys to facilitate faster and cheaper drug testing.

Through this process, I felt what it was like to be an engineer working with medical devices. As a group, we moved from the brainstorming phase all the way to the testing and redesigning phases. This is an aspect of undergraduate research that should not go unmentioned. The feeling of working in a lab with peers who are just as passionate about a project as you are on a product that could very well benefit the well-beings of many people is one that, in my opinion, can best be achieved by working in an undergraduate research lab.

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THE CATALYST

The Catalyst is UMD's undergraduate bioengineering research journal. We are looking to publish a variety of related undergraduate research with our tenth issue coming this Winter 2019! If you are an undergraduate student working on research related to biomedical engineering and biotechnology, you are qualified to submit a research blurb. Contact us via email or submit your research abstract through the link provided below. Please check out our previous issues as well. We are dedicated to serving the University of Maryland community and those interested in undergraduate research. For further questions please contact us at thecatalystumd@gmail.com.

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