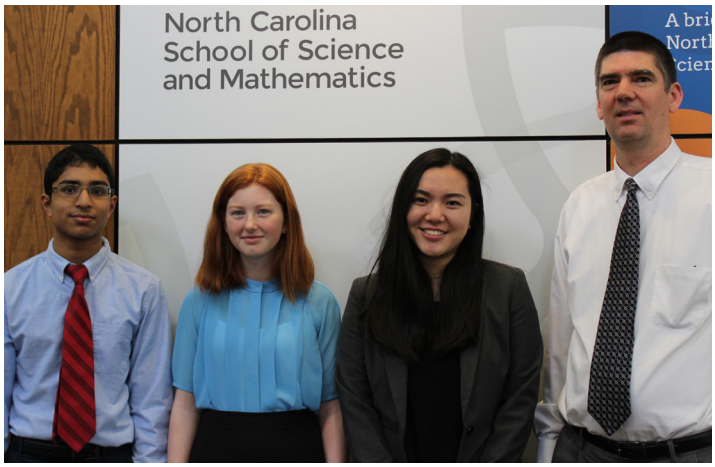
AN INTERVIEW WITH DR. JOSEPH DESIMONE



Left: Dr. Joseph DeSimone, Chancellor's Eminent Professor of Chemistry at UNC, William R. Kenan Jr. Distinguished Professor of Chemical Engineering at NC State and of Chemistry at UNC, Co-founder and CEO of Carbon, Co-founder of Liquidia Technologies, Bioabsorbable Vascular Solutions, and Micell. Dr. DeSimone is also a former member of NCSSM's Foundation Board of Directors and is an inaugural inductee (2017) of the NC STEM Hall of Fame.
Right: Sreekar Mantena, BSS Chief Editor; Corinne Miller, BSS Essay Contest Winner; Isabella Li, BSS Chief Editor; and Dr. Jonathan Bennett, BSS Faculty Advisor.

What are the things you love most about the scientific community? What are the things you like least?

I love the esprit de corps around trying new things, trying to improve the health and well-being of society. I love the motivation for trying to realize that you can make something better that impacts lives. Innovation is really important, and we've got lots of problems. I love the utilitarian aspects of research. Probably one of my favorite lines is from Melinda Gates, Bill Gates's wife: "Science enables our caring to matter." I found that really inspirational; it becomes a toolbox to really help drive and motivate you, especially about helping people and improving their lives.

What don't I like? You know, I think, on the research side, it has become very competitive to get research funds. And I think it's leading to outcomes that we as a society and we as a nation need to be very careful about. In the biological sciences, who mostly get funding from the National Institutes of Health, the average age of a person who gets their very first grant is 43. You know, I'm over the hill and I'm 52. When Carolina hired me as an assistant professor, I was 25. I look at all the people here in Silicon Valley, where I'm at now — imagine if nobody got any funding until they were 43. It's a problem, and I don't like the fact that a lot of young people are being cut out of the system, they're not moving forward. When you look at the diversity and balance of funds going to different people, of different backgrounds, it's not balanced and reflective of society. The number of people from underrepresented groups in sciences who get funding is low, and it's perpetuating the situation. We need to realize that diversity is a fundamental tenet of innovation, and that funding is not being spread around in an effective away. Just look at university faculty, being not representative of the student population. And these things all contribute to what I think is a problem, and it's something I'd like for us to be aware of.

Can you tell us about CLIP (Continuous Liquid Interface Production), the basis of your newest company, Carbon?

It's an amazing breakthrough that I think of now as a software-controlled chemical reaction to grow parts. We use light and oxygen in combination to grow parts. I think of light as our chisel. Patterned light is solidifying a polymer in very selected areas and in a very selected volume fraction. Oxygen inhibits the chemical reaction that light triggers — we pioneered that. It allows us to print 100 to 1000 times faster than traditional 3D printing with really exquisite complexity and surface structure. And on top of that, we've invented some great materials. These materials have the properties to be durable for a wide range of applications, from running shoes to medical devices to car parts, and it all comes together with a piece of hardware that is built from the ground up to be completely controllable with software.

When I grew up, most of a car was controlled by a human.

You pushed a brake, that was pulling a cable, and it applied pressure to the back of the car. Or you've got a steering wheel that connected to the wheels that you can turn. Now, if you drive a Tesla, it's more like fly by wire. There are electronics sitting in the back of the wheels that go to the brakes; everything is software controlled and done with codes. Our printer is designed in the same way. Everything about the printer is software controlled. So that, combined with light and oxygen, makes it the very first digital fabrication technique that makes three dimensional printing possible.

What are the benefits of 3D printed objects and materials over traditional parts when manufacturing? How do you anticipate manufacturing to change over the coming years due to advances such as CLIP in 3D printing?

You guys are too young to know, but when you think about making copies of one paper (like exams and things that you wrote), it wasn't too long ago that there was something called a mimeograph machine or a copy machine. There was a master template and people worked long and hard to get a master template and then they would make lots of copies of those pages. And now, today, you have a digital laser printer. And writing and printing has all gone digital. It's changed the way we work and collaborate. You guys, when you write something, you use Google Docs or Microsoft Word, and you pass around versions, and you edit it, and you collaborate. When you want to make lots of copies, you make just the number of copies you need. People don't print lots of copies of books and magazines anymore and store them in warehouses. They are made on demand and you make the amount you need, where you need it when you need it. It's changed the supply chain and disrupted everything.

When it comes to 3D polymer parts, whether it's a running shoe or car parts or medical devices, I would argue that we're still in the mimeograph ages. There is no digital fabrication technique that has emerged to have the quality and unit economics necessary to produce real parts. 3D printing has been touted as that digital technique, but traditional 3D printing does not scale in quality or speed necessary to be a true production application.

CLIP, we believe, is the first example of a truly scalable, economically-viable digital fabrication technique that will usher in a new era of what people can make, how they design them, how they're engineered, and how they are ultimately delivered to customers. I think it's ushering in a really profound new age of digital fabrication that's going to have a profound impact on how people design products and what products people design. I think it's going to disrupt supply chains, and I think it's going to speed the economy to allow companies to go faster and make things they could never make in the past.

You have founded multiple startup companies beyond Carbon. What has been your experience of working in industry compared to working in research with a university?

All of my startups prior to this current one, I did as a faculty member. UNC-Chapel Hill has very good policies and procedures that are very clear that allow a faculty member to start and launch companies, often with students. They have real good conflict of interest management policies and procedures. It feels very intrusive, it's thorough, but it benefits the students, it benefits the faculty member and the institution. After doing that for 25 years, starting several companies as a faculty member, and graduating 80 Ph.Ds in my career, half of which are women and others underrepresented in science, when I had this new invention, I decided to step away from my academic posts and moved into being CEO of Carbon.

It's very different and very similar in so many different ways. In a nutshell, we have a really good esprit de corps here. I have a team that wants to make a difference in society. We work at the intersection of hardware engineering, software engineering and molecular science. I compete, for example, with software people at Facebook and Google. I think we compete well with those employees - they get to choose where they want to work, because we have a really good purpose. Engineers love to solve hard problems. We've got to change the way people design, engineer, make and deliver customer products. A lot of software people now are being asked to write better algorithms to push ads on you. That's not that engaging if your craft in life is software. Who likes getting lots of ads? Noone. That's just not a rewarding career.

I love the purpose-driven aspects of our company, that's a lot like a university. There's a lot more pressure on me than I ever had at any university. I've never worked so hard in my life. Being a faculty member is a treasured society, one that I really enjoyed. I worked hard as a faculty member, no question about it, but I didn't quite have the pressure on me that I have with 250 people working for me. When I come in to work in the morning and leave at night, I think about car payments and house payments and college tuitions. It's a lot of pressure that I didn't quite have at the university.

Many students at NCSSM are interested in research and entrepreneurship. Did you always know you were interested in these fields, and what advice do you have for students looking to pursue this in the future?

No, I was not. The word entrepreneurship was not in my

vocabulary for the longest time. As a researcher both in undergraduate and graduate school, I was very utilitarian in the Thomas Jefferson notion of doing research that can impact people's lives. I've always loved that. I never thought about that in the context of being a business person and trying to drive that myself.

The idea of being an entrepreneur myself was probably born out of frustration. If you are an innovator, and you are completely reliant on third parties to bring your innovations to life, that often can go sideways for a myriad of reasons that are outside your control. One of the most important is what I would say is entrenched interests. If you had an idea, a better way of doing something, and you licensed it to an existing company that had competing technologies, your new idea could get canned simply because they did not want to make the investment or because they already paid for a plant and wanted to be more cash efficient. It has nothing to do with your technology. What I love about being an entrepreneur is you get to make your ideas happen with singular focus.

Early on in the academic year, there was school-wide discussion on the merits of lesser known colleges over big-name universities. Having attended a small, liberal arts college near where you lived, what was it like for you to attend such a school and how do you think it impacted your success down the road?

In my case, Ursinus College was basically in my neighborhood growing up, outside of Philadelphia. My father was born in Italy. He was a tailor, and didn't go to college himself, so I was first-generation to go to college. We didn't have the means to attend and live at Ursinus College, we couldn't afford my family sending me there, but what I did was work two jobs while going to school, living at home. I got a great scholarship being a "townie" which I really benefited from. I'm a big believer in a liberal arts education to change lives. And I see it firsthand; I'm living it firsthand. I think there are some big universities that have a small-college, liberal arts feel — UNC Chapel Hill is a great example of that. I think it's a matter of how people fit and what their local circumstances are. I don't draw the distinction too much between big schools and little schools, because I think there's pros and cons of both. Obviously for graduate school, you have to go to a pretty big place to get the range of research in science and engineering.

One of the challenges with public universities is, because of financial constraints, we are ushering students through these schools, more focused on throughput than a focus on each student. The great part about not going to public school was experimenting with classes that you may or may not be good at, or may or may not enjoy. Now it's getting harder to drop or change classes at some of the big public schools, because they are constrained with getting you through there quickly.

What led you to pursue research over other careers with your degree?

So I fell in love with research as an undergraduate. I loved the hands-on aspect of it, I loved the methodic aspects of it, and I was good at it. I loved it because it made the classroom experience that much more rich. There's nothing like doing in a lab something that's related to what you're doing in class. It brought it to life for me, and I really enjoyed that.

You mentioned that there is a struggle for young scientists to get funding. What can young scientists do to make themselves more likely to get funding?

That's a terrific question. There is a business phrase that strategy is all about being different, and I think the same goes in research. I think different ideas, compelling different ideas, are what I would try to focus on. As opposed to a me-too or a me-three. Work in areas that no one else is working in and say well "how do you do that" ?

Bridging fields is one of the richest fertile grounds for doing something new. When I was growing up academically, there was a metaphor between an I-shaped person and a T-shaped person. An I-shaped person was very monolithic and deep in a particular subject. A T-shaped person was also deep in a particular subject but had the agility to collaborate with others. I think the more appropriate metaphor today has gone beyond T-shaped and includes π-shaped or comb-shaped. We are deep in multiple subjects. I think that's a higher calling than just being a T-shaped person. T-shaped people and I-shaped people collaborate often via a common language. I think a common language can dumb down certain topics. A π-shaped person is more multilingual. Being multilingual is a higher calling than a common language. I'm attracted by those people who are polymaths and deep in multiple subjects, who understand at their core these multiple subjects, and are able to see the connections and do something that is very different and differentiate it.

A lot of students at NCSSM do research and have experienced failure. How do you cope and move forward?

In many ways, it certainly is part of the pathfinding process to find out what's not possible and to still move forward. Failure is really all about finding the edge of possibilities. You don't know where the edge is until you get past the edge. Having a good knack of understanding that whole process, and thinking about it as a probing way to find the edge, is how I think about failures. It's just intrinsic to what we do.

What are you interested in outside of work?

I love spending time with family. In North Carolina, we had a wonderful home in Chapel Hill and a wonderful place down at Holden Beach, and we enjoyed that many weekends. Things are a lot more expensive in California, although we have a wonderful place. I do a daily exercise routine, I have to just to keep my sanity. Going for mounting bike riding in California is addicting. I also have a 13-month-old granddaughter who takes up a lot of my spare time, and experiencing that with the little one has been a lot of fun. And I've been able to go to two Final Fours in a row at UNC-Chapel Hill and then just got back from a Super Bowl game this weekend.