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CONVERSATION

Early-career researchers: an interview with Kakani Katija

Kakani Katija is a Principal Engineer at the Monterey Bay Aquarium Research Institute, USA, where she designs and builds instrumentation to study marine invertebrate ecomechanics. She received her Bachelor's degree in Aeronautics and Astronautics from the University of Washington, USA, before moving to the California Institute of Technology, USA, for her Master's degree in Aeronautics with Morteza Gharib and PhD in Bioengineering in the laboratory of John Dabiri, completed in 2010. Katija was recognised as a National Geographic Emerging Explorer in 2011 and has given presentations at TEDYouth and TEDWomen.

How did you become interested in science?

I was very good at math growing up. Mathematics was, and continued to be, my back-up plan. I knew that if I did horribly in any other course, my math grade would keep me up.

In the US, there is this natural progression of childhood interests from being excited about dinosaurs to wanting to become an astronaut, and that was the path I followed. For whatever reason, I also wanted to be a scientist. I really wanted to wear that lab coat and I had no idea how to go about doing that since my family were not from an academic or scientific background, but they were supportive in what I wanted to do.

What inspired you to study aerospace engineering at university?

I came from a background where going to college meant getting trained for a job. Initially I was interested in biology – the sciences in general – but at some point I thought, 'At the end of this I need to get a job', so I decided to look into engineering. Engineering is a field where students are essentially guaranteed a position out of undergraduate studies. Advanced degrees are not required and you can have a very comfortable lifestyle with an engineering degree. Out of the engineering disciplines, I found that aerospace engineering was the area I connected to the most, because I've always been excited by space exploration and being an astronaut. That was the thread of reasoning that inspired me; it was largely a practical decision.

Why did you choose University of Washington for your degree?

It's funny, because the early part of my life, up through college, was really defined by my athletic pursuits. I used to be a figure skater competing with my brother in ice dance; that was really my focus at the time, and where I developed my work ethic. I decided to go to the University of Washington because I was training in Seattle for figure skating; it was the only university I applied to. At the time my brother and I were on the US international figure skating team and that was my focus, but within my family, education was always prioritized. My parents' attitude was, 'Yes you can focus on your training, but if you have to decide between making class for a few weeks versus doing some training event for skating, we'll always choose school'. Education was always something I did alongside my training, which can be very different from other high-level, competitive athletes in general. Sometimes education can fall by the wayside, but in my case my family saw it as a ticket to success.

How did you become involved in figure skating?

My brother and I skated separately at first; we started when we were around 5 years of age. We just happened to go to a shopping mall, there was an ice rink there and we wanted to try it. Our parents paid a couple of dollars for a public session and a coach saw us skating and thought we had talent. One thing led to another and we were heavily involved in the sport from the age of 5 to 20–21.

We were not that seriously into training until my brother and I started to skate together when I was a teenager. Then we moved to Seattle with our mum – when I was a sophomore (second year) in high school – and we started training pretty heavily. That involved 2–3 h a day on the ice and 2–3 h a day off the ice, doing ballroom, ballet, weight training, on top of high school or college courses. We competed at multiple levels in national and international competitions – at the novice, junior and senior levels – and we were selected as the second alternates for the US Olympic team in 2002.

But then I began struggling with an injury. I had surgery and while undergoing 6 months of physical therapy, I was applying for graduate school. I was accepted to different graduate programmes, including a chance to stay at the University of Washington or to leave to go to Caltech. We had been so close to going to the Olympics, but then I had these other opportunities: Washington would allow me to continue competing but all the others would not. I went and visited Caltech before I accepted the graduate school offer and I spoke to faculty members and asked them if they thought it was feasible to continue competing while I was in the programme. Every single person said 'No'. I came home and I thought, 'I have this amazing opportunity, I have been offered a full ride at a really great graduate school', and so in the end I decided to go to Caltech.

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It was a really emotional decision because I wasn't the only one affected. It was challenging because when you have worked so closely with someone for so long to attain this dream, it is tough to give it up. I credit a lot of my work ethic, stubbornness and ability to focus on the end goal to the sport, to being that involved in a pursuit early on. Time management was engrained in me, and it really gave me perspective. Later on in graduate school, whenever I felt incredibly busy, I'd take a moment and realise that I was much busier when I was competing.

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What did you study at Caltech?

I started the graduate programme at Caltech in Aeronautics because it had really close ties to NASA's Jet Propulsion Laboratory (JPL). I really wanted to work in space exploration so I was going to complete a 9 month Master's programme and then apply for a job at JPL. But that never happened, because I started getting involved in research during my first year. Mory Gharib was appointed as my advisor. He studies fluid physics and how that affects biological processes – for example, how heart valve biomechanics affects circulation. That was my first introduction to biological fluid mechanics and I was fascinated. Then I transferred to work with John Dabiri. He had been Mory's graduate student and he worked with me on my Master's research project before starting his faculty position at Caltech. As one of his first graduate students, I was really grateful for the experience of seeing how a research lab was put together. I learned that if you did not have everything in place all at once it's OK, because you can be very strategic in selecting projects or prioritising efforts that will help you to succeed.

My research with John was to look at organismal systems through a fluid mechanics framework for models of bioinspired design. I was very excited about the work and opportunities for research, and these efforts have led me to study marine invertebrate ecomechanics, which is the intersection between ecology and biomechanics.

What did you do after graduate school?

I have moved around a lot. My first position was at Woods Hole Oceanographic Institution (WHOI). I had applied for engineering faculty positions at the end of my PhD and had received offers. This is pretty common in engineering – having postdoc experience is nice but it is not necessary to get an engineering faculty position. However, I didn't feel ready to take up a faculty position right away and wanted to do a postdoc to expand my knowledge base and come up with new areas of research. I accepted the postdoc at WHOI, and found it was an amazing educational opportunity because it enriched my understanding of marine ecology.

However, my career choices were not mine alone as my husband completed his PhD in Mechanical Engineering from Caltech at roughly the same time. Unlike some couples we know in academia, our desire to live together in the same place was non-negotiable and we made sacrifices to solve that problem. When I accepted the WHOI postdoc, his job status was not confirmed, but shortly after moving he started working as an engineering consultant for a private company. Then, several months later, he was offered a postdoc position in Mechanical Engineering at the Massachusetts Institute of Technology. But then our contracts were offset – his postdoc duration was 2–3 years – so I had to figure out a way to either extend my postdoc or apply for jobs in the area. WHOI is a non-profit research institution where scientific staff are on soft money, so all of your salary and all of your research efforts are externally supported. In order to extend my postdoc there, I had to apply for grants early on.

I also became an adjunct faculty member at Bridgewater State University and I picked up some salary doing engineering design work on the deep-sea submersible Alvin. I was trying to cobble together a pay check. After an unsuccessful faculty interview at Hopkins Marine Station (HMS), I had met some members of the faculty there who said, 'It would be wonderful if we had somebody like you with your experience and perspective here'. Stephen Palumbi later put together a package where I could come and be supported for a year to do research in the HMS Marine Life Observatory, being mentored by Mark Denny.

At this time I was so close to quitting after doing multiyear postdocs and feeling that little had come out of it, while my engineering friends were having very successful careers in industry. I honestly did not know if I could keep on in academia. But I decided to take the opportunity at Hopkins, where I got to know Barbara Block, and through her I met Bruce Robison at the Monterey Bay Aquarium Research Institute (MBARI). Later, I was offered an MBARI postdoc fellow position prior to starting at Hopkins. I saw my time in Monterey Bay as an opportunity to give academia one last go.

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My postdoc mentor at MBARI is Alana Sherman and she has been absolutely wonderful! After a successful first year, I applied for faculty positions in engineering, oceanography and biological sciences. My family and I were just so humbled by the generous offers and I recently accepted a PI position at MBARI. My title is Principal Engineer and I'm finally in a position where I don't have to define if I am an engineer or a scientist – I am both.

Given your postdoctoral experiences, how could we change the current structure and culture of science to better support aspiring scientists?

I would have gone through a lot less heartache if I had received advice on how vital mentoring is. I think it's really important for students to find a variety of mentors with different careers and personal lives, and to learn how to evaluate the context from which that advice comes. For example, in grad school or during your postdoc, you look to your advisor as a person to go to for advice and they will advise you based on their own life experience, which may or may not jibe with yours. In the end, you are trying to make a decision for yourself and your future, and some mentors will provide great advice for one aspect of your life while other advisors will provide great advice about others. Recognising where advice comes from, whether it should apply to you, and that no one's feelings are hurt if you don't take it, is a skill. I think it would be beneficial to have a workshop on mentoring for students. People say that networking is important, but speaking with people at meetings

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How did National Geographic come into your life?

That happened right around my time at WHOI. I had started the postdoc and then National Geographic sent me an email congratulating me on being a 2011 National Geographic Emerging Explorer. To this day I do not know how they selected me. They invited me to headquarters in Washington DC and I gave a 10 min talk to a really excited, knowledgeable and forward-thinking audience. At the time I thought it was probably one of the most important talks I had given. I spent an entire week at National Geographic headquarters to meet with their different media outlets. This allows them to put a face to your research or exploration efforts and tell your story; this is what sets National Geographic apart from other science or exploration news outlets. We are invited back to headquarters every year for the Explorers Symposium.

You have given several TED talks, can you tell us about that experience?

In an email that I received out of the blue I was invited to TEDYouth, to give a short talk to middle and high school students at the Brooklyn Museum in New York, and TEDWomen in Monterey, CA. After getting in touch with you, which they do months in advance, they assign a speaking coach and they work very closely on 'your message', refining your elevator speech, going through the visuals you will use, etc. What really struck me was the focus on how you go about telling your story. People don't connect with your research, they connect with you, so having a coach to assist with telling your story is just a phenomenal experience. I wish that everyone could have that opportunity, because it has changed how I approach seminars and presentations. Once you and your coach decide on the narrative and your visuals, you practice your talk. I cannot tell you how many times I have practiced my TED talks, it's impossible to count. Then about a month before the TED conference, you give your talk to the TED organisation on a video call and they critique it. You then have a few weeks to finalise your talk and send them your slides.

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Before the conference begins, you run through your talk on stage with your coach and you have to wear the outfit that you are going to wear during the talk because they want to get the lighting, the camera positions and your delivery right. On the day of my talk, I had to sit in a makeup chair for 2 h: they are getting you ready for high-definition video. Before the actual presentation, they remind you that this is a production and that they have multiple cameras pointed on you. They also record your soundtrack separately, so if you bumble a word or phrase they will remove it from the soundtrack later and cut to another camera angle – no one is the wiser. So, if you are thinking that these TED talks on the internet are amazing, don't worry, that was not what it was like when it was given.

You attended a JEB symposium in 2011; what was your experience of the meeting?

I loved it! It was the first time I got to attend a small workshop in the biological sciences. I had read Mark Denny's papers, and Michael Dickinson was also there for a short time. It was my first opportunity to meet with and interact with people in this community. At the time I was still in graduate school, but the other postdocs and PIs included me in the discussions about ecomechanics. It is those relationships that have sustained me in academia. It was a wonderful opportunity to be included and involved.

What scientific problems are you working on now?

My interests have expanded beyond my PhD work in jellyfish swimming mechanics and biomixing – there are so many interesting questions about jellies and other midwater organisms (like larvaceans) that need to be addressed because so little is known about their natural behaviour. We have three development projects underway: bio-logging tagging packages for soft-bodied invertebrates called ITAGs (collaboration with MBARI, WHOI, University of Michigan and Loggerhead Instruments), a new class of underwater vehicle called the Mesobot, which will non-invasively track organisms using stereo cameras for long durations (collaboration with MBARI, WHOI, Stanford University and the University of Texas Rio Grande Valley) and an instrument called DeepPIV that enables quantitative measurements of fluid motion over the depth range of the ROV [remotely operated vehicle] that it is deployed on. For animals large enough to carry a tagging package, the ITAG will simultaneously measure behaviour using accelerometers and magnetometers, and the physical environment using salinity, temperature, pressure and dissolved oxygen sensors. For organisms that are too small for tagging, the Mesobot will allow us to follow and observe their behaviour for at least 24 h, hopefully up to a week. We just started the development this year and there are plenty of applications for the vehicle that cuts across fields in the marine sciences.

There is a need for better instruments, better observational tools and techniques, and so now my efforts have largely shifted to trying to provide those for the community

This is one of the reasons that I am so grateful for the experiences that I have had in the biomechanics and oceanographic communities. It was through those experiences that I realised there is a need for better instruments, better observational tools and techniques, and so now my efforts have largely shifted to trying to provide those for the community.

Kakani Katija was interviewed by Kathryn Knight. The interview has been edited and condensed with the interviewee's approval.

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