Oklahoma Innovations Radio Show

Air Date: August 29-30, 2015

Guests: **Arvind Santhanakrishnan**, Oklahoma State University Department of Mechanical and Aerospace Engineering

>> From the OCAST Radio Network, this is *Oklahoma Innovations*, a weekly science and technology radio magazine, brought to you as a service of OCAST, the Oklahoma Center for the Advancement of Science and Technology. OCAST is the state's only agency whose sole focus is science and technology. The OCAST mission is to identify and fund promising research and technologies that allow Oklahoma to compete in a global market economy from our own backyard. This program features some of Oklahoma's most gifted scientists, inventors, entrepreneurs, manufacturers, educators and business leaders who all have one common goal: developing technology based economic growth for all Oklahomans. Now, here are your hosts Gary Owen and Chad Mullen.

[Music]

>> Welcome to this edition of *Oklahoma Innovations*. We are delighted that you've joined us. Tessa has gone on to do some new things at OCAST and she recently got promoted. Chad Mullen from OCAST. Chad, welcome to the mic. You've been on our program before kind of as a guest.

>> Well Gary, thanks. Excited to be joining the radio program and just want to take a moment and say a few things about Tessa. She is a very, very valuable member of the OCAST team.

>> She is.

>> She recently has taken on a lot of new roles and responsibilities. One of the things that we've dealt with as an agency is pretty substantial budget cuts over the last 4, 5 years. So we are having to do more things with less folks, with less money and she is playing an integral role on that. So she is-- her time has been consumed with moving our agency forward but now you are stuck with me but I'm excited to be here.

>> Alright. Well tell the audience a little bit about what you do at OCAST.

>> Great. Basically my job here is I am a Director of Government Affairs is my official title. We run very much like small business so that may include talking about the purpose and the mission of OCAST and the importance of it with elected officials, state leaders. And it may involve picking up trash one day. We are very, very small business here so we all work together. But basically my role is to go out, look for strategic partnerships with other entities, figure out ways that we can do more with less and then communicate the value of OCAST. And more importantly and more broadly the value of science and technology on our economy and our impact with those that can make decisions about our future.

>> Awesome. Well I want to tell our audience about our subject matter this week. We are going to be talking with a gentleman who is an assistant professor at OSU in the school of Mechanical and Aerospace Engineering. And some of the topics we are going to be talking about this week are fascinating. We are going to be talking about everything from heart research, the development of some new innovations in heart therapy. Also we are going to be talking about-- you know, there's-- over the last couple of years there's been some interesting stories about

drone technology. And the engineering department is studying flying and swimming insects. Little, tiny insects and how they fly so that engineering innovation in the development of insect sized drones. That would be something to really be putting our military and law enforcement and other investigators into. Also we are going to be talking about vertical access wind turbines. They are studying the flow of wind and how wind moves through these turbines. And also interesting is the feeding and the pumping of water and how they filtrate all those microbes in the sea with upside down jellyfish. You ever seen those tentacles on jellyfish?

>> Well you know, I generally run from jellyfish.

>>Well but you've seen--

>> But after reading up, yeah.

>> You've seen them in aquariums.

>> I might run to them now.

>> You've seen them in aquariums.

>> Absolutely.

>> So then we are going to be learning why they are studying jellyfish. It's a fascinating-- stuff going on at OSU. So we will talk with guest Arvind here shortly. So tell us what is going on at OCAST?

>> Well Gary thanks. A couple of exciting things. This past Wednesday we held out technology showcase. This was our fourth annual showcase. We had about 300 folks show up for the event. It was held at the Northeastern State University Campus in Broken Arrow. It's a beautiful campus, beautiful facility. We heard from 6 great companies. We had a great speech at lunch by Google with a pretty amazing robotics competition that happened afterwards. So it was a big success. We are looking forward to next year's. We are already starting to plan it. No rest for the weary or the wicked. And we will hopefully announce soon where that will be and what the date is so you can put it on your calendar. I would think the other big news that we have going on is our intern application program is underway. The deadline for that is September sixteenth. That is one of our programs that we have worked hard to try to connect mostly engineering students with manufacturers and businesses across the state. So one of the things that we know that exists in Oklahoma is a dearth of talented, skilled work force and that is especially true in the engineering fields. And especially true in the rural areas of the state. And this program-- with this program we have seen a lot of rural businesses and manufacturers take advantage of getting some students from OSU, OUTU and many of the regional universities to come out, do an internship and then later on they go back to work at that company in those areas. So we have seen a lot of success. It's a little-- it's quite a bit different than any of our other programs. So if you're a rural manufacturer or a rural business in Oklahoma. I'd encourage you to reach out to OCAST and look into that program. It's really great. The other big news I would say-- this is really kind of a plug for the Science Museum of Oklahoma. They've opened a new exhibit called "Curiocity" which is curio-city, a little play on words there. Have completed revamped that center. It is-- no matter where you live in the state, it is worth a drive if you have a child that is, you know I'd say between 3 and you know, 10 or 12 or if you are a child at heart like me [laughs]. I really enjoyed it. It's worth a trip up to come check it out. It's pretty amazing and it will really inspire your kids to get interested in science and technology. And that's it at OCAST this week.

>> Awesome, awesome, very cool. Alright, our guest this week is an assistant professor in the Mechanical and Aerospace Engineering Division at Oklahoma State University. And-- very interesting young fella and we are going to learn a lot about what is being-- on the innovation table if you will at OSU. So let's talk with Arvind Sana-- Santhanakrishnan, did I pronounce that right? I hope that is so because you have a long name here.

>> [Laughs] Yes.

>> Okay.

>> It's Santhanakrishnan.

>> Santhanakrishnan, okay. And so, you're from India?

>> Yeah, yeah.

>> Okay. When did you come to the US?

>> So I grew up in the coast of India and I loved, you know, just getting to watch a lot of the aquatic fishes and everything--

>> Oh wow.

>> Birds around it and always been interested in sort of understanding things that I couldn't understand. Sort of made me feel stupid. You know I guess I have a way of putting myself out there to figure some stuff out.

>> We all feel that way all the time.

>> Right so [laughs].

>> Hey, tell us about what I thought was interesting in your bio it says how you got interested in engineering as a kid. This is a really interesting story. Talk about that.

>> Yeah so as a kid I always got into trouble quite a bit because I started breaking stuff when I was very little. And I think a lot of children do that but I was notorious especially because I would break apart my father's transistors--

>> Oh no.

>> He used to follow all these sports games, you know, hiding away from my mother. And so it was his only source of entertainment. And so you know, I left him with nothing a lot of times. And a lot of times it was me trying to figure out what it actually does, where does the sound come from? And I could never understand that and so you know, the natural thing to do is to break this and then-- but you know, my dad was always, "Why can't you put it back together? And nobody will be in trouble". And I was like, "I don't know how to put it back together".

>> It is always easy to take it apart.

>> [Laughs] Yeah so-- and then my grandfather was sort of a self-styled mechanic, auto mechanic. He never went to college and he fixed cars and some motors until he was 90 years old.

>> Wow.

>> He was a farmer. And so watching him put stuff together was very meticulistic attention to detail. And built my bike, you know all of those things and so that was you know, inspiration

starts at home I guess in a way. And so my decision to go to engineering was because I wanted to figure out how to build stuff. How to break stuff, build it back together.

>> So you basically were a curious young guy from-- [inaudible].

>> That's really it.

>> Oh wow, that's great.

>> Well, you know, I think Gary one of the differences between me and genius is just that I just broke things as a child.

>> Yeah.

>> I didn't put them back together and didn't learn much from breaking them. Well Doctor, tell us a little bit about what you do at OSU and what brought you to OS-- Oklahoma State University?

>> So I got my PhD in Mechanical Engineering at Kentucky and you know, I really enjoyed-- I taught classes there and I really enjoyed the southern culture if you will. The students where, you know there is a lot of people from rural areas just like OSU and Oklahoma-- in general. And the students are very curious people. Sometimes it's the first people in their family to go to college and in a way my dad and mom never went to college and they just got-- made it to high school. They had to get to work. And so for me it's a way of kind of connecting back to that, you know, the sort of-- the part of the society where you know, they don't know whether they can do it but I think everybody can do what I am doing. It's just a matter of perseverance and hard work and curiosity really to keep things going even when nothing is working out. And so Oklahoma State, my interview here-- the culture-- the student culture reminded me a lot about that experience that I had and really that was my formative time in Kentucky where I decided to stay in academics. I got job offers to go to industry with much higher pay but I really enjoyed the working with students, mentoring them and sort of seeing through their eyes how they are experiencing learning something for the first time. And so, the environment really was conducive for me to come here. So I think that is one of the reasons I liked OSU a lot.

>> Well I think that's great and we appreciate you choosing to stay in the field of academics and inspire the next generation. I think you bring up and interesting point Gary that-- you know, Oklahomans I think take advantage just how innovative some of our farmers and ranchers are and the way they do things. And you alluded to that with your grandfather so it's always good to hear some validation on that. I think we've got just a couple of quick minutes. What are-- you're working on a lot of projects at OSU. Just what is your favorite one and if you could briefly describe it that would be great.

>> So another interest of mine when I was in-- maybe in high school. I was really, you know good in biology and I wanted to go to medical school to become a neurosurgeon. That was another wild ambition. But my-- you know, when I was writing or trying to light fireworks in festival season or whatever, I didn't have a steady hand. So probably wouldn't be a good decision for me to try and operate on someone's brain.

>> But you could have designed a robot to do that for you.

>> Right exactly. So in a way my cardiovascular work is sort of my vicarious way of getting back to the field of medicine. Not in the way that clinicians and surgeons do. They're saving lives every day. Unbelievable, amazing stuff that they're doing but this is a little way in which an

engineer can sort of try to help. You know, give some new information about a disease and interestingly, Oklahoma is you know-- cardiac health is ranked poorly so in a way this is very a great place to actually start establishing that type of work I think. So that was-- that's been one of my very interesting passions and thanks to OCAST I've been able to make that go further.

>> So you're doing some research on left ventricular dyssynchrony? Is that the way-- is that right?

>> Aha.

>> That is a big title but basically it's understanding the wall motion delay effects of blood flow, is that right?

>> That's exactly right.

>> Okay so we have-- we only have a few seconds here. I wanted to kind of tease the audience. This research he is doing and the kind of innovations that they're attempting here is really fascinating. And you are collaborating with Doctor Martin-- Edward Martin at the Oklahoma Art Institute on MRI measurement and those kinds of things so it's-- we've got a good segment to talk about when we return. We are talking with Arvind San-- Santhanakrishnan.

>> That's perfect.

>> Assistant Professor of Mechanical and Aerospace Engineering at Oklahoma State University. We have a lot more fun to talk about and I-- I'll tell you what I'm looking forward to is listening to his research on insects and jellyfish and why they're doing that. You'll find out when we return on *Oklahoma Innovations*.

[Music]

>> When I invented my new product I faced a lot of challenges from securing capital to recruiting qualified employees. It's a very complex path from innovation to the market place and I needed some help navigating the process.

>> The Oklahoma Center for the Advancement of Science and Technology and its strategic partners: The Oklahoma Manufacturing Alliance and i2E help entrepreneurs. They support existing and startup companies so they can succeed and create jobs, increase per capita income and grow the state's economy. In its 26 year history, OCAST has funded nearly 2500 research projects and provided support to 100's of Oklahoma based companies. The investments made in these businesses yield high returns for our state by strengthening and diversifying our economy. Advancing innovation is investing in a positive future. That is what OCAST is all about. For more information call OCAST toll free at 866-265-2215 or visit us on Facebook or our website at OCAST.OK.GOV.

>> Now in its twentieth year, this is *Oklahoma Innovations* on the OCAST radio network.

[Music]

>> Mechanical and Aerospace Engineering at Oklahoma State University was organized as Mechanical Engineering in 1923 with a faculty of only 3 professors and a handful of students. Aeronautical Engineering was first offered in 1928. Was fully accredited and as a stand-alone curriculum in 1960. 8 years later, the school was reorganized as Mechanical and Aerospace Engineering and since then, the Mechanical Aerospace bond has grown stronger each year. And today it has forged an inter-disciplinary program that is among the strongest in the nation. Our

guest this week is an Assistant Professor with the Mechanical and Aerospace Engineering Department at Oklahoma State University. Arvind, you have a-- quite a background. We've learned a little bit about your interest and Chad has a fascinating question because he is with OCAST. You got an OCAST grant recently. Let's talk about that, guys.

>> Well I would like to talk to you a little bit about kind of what you alluded to in the first segment which is Oklahoma has a pretty significant issue with heart disease and cardiovascular disease. And some of the contributing factors of that and it sounds like you recently applied form 1, an OCAST Health Award to work on at least a portion of that. Tell us a little bit about your research and what you're hoping ultimately to accomplish with that award.

>> Yeah so the heart failure is a very-- pretty significant problem not just in Oklahoma but around the country and a lot of parts of the Western World. And in Oklahoma specifically maybe 1 in 4 or even more than that of people suffer from heart disease every year. And so it is a very significant portion of our population. And the-- one of the diseases I am trying to focus on is when your heart decides to not pump correctly and so what I mean by that is the heart moves similar to the way you think about, you know a flexible sack since moving in and out to fill blood and pump blood. And so in these particular patients there is what is called dyssynchrony meaning that the wall motion is erratic so there is no coherence anymore. So there's-- if you can imagine trying to fill a balloon and you've got-- and trying to pump it but you sort of apply pressure from all over the place. The fluid inside the balloon is not going to be-- it's going to be heavily disturbed. So it's going to sludge around. You may not get as much blood that you want to the rest of your body and so that affects quality of life. These people probably cannot climb stairs without getting exasperated and so it's a very significant problem from the patient quality of life standpoint but also economically it's a big problem because these patients undergo most commonly-- they are not receptive to pharmaceutical therapy. They go through a pace maker implantation and alternate is cardiac resynchronization therapy. And so there the electrophysiologist-- the clinicians implant leads in the chest. They help to control the electrical activation time so that your heart starts pumping correctly. And the problem is the electrophysiologists don't have a whole lot of information mechanically where to place the leads. So ultimately if you're trying to activate particular segments of the heart you need to know which segment matters more, which segment doesn't matter as much. And turns out, this therapy is over $100,000.

>> Wow.

>> Including the hospital stay and while a lot of people do show improvement in the short term: 6 months or so, 30% or more 40% sometimes do not show any improvement at all. So it's an economic burden on the country. And so it's a very complicated problem and a lot of clinicians have actually scared me into, you know, "Hey why are you doing this? This is really complicated". And like I said I have a way of getting myself into things that I don't understand.

>> You love challenges [laughter]. Yeah.

>> And so what we are doing is we are starting with the-- there is no established well-developed animal models at the moment and so what we are doing is we have a very controllable artificial heart model in the lab. It's made out of silicone. I can see through the heart model and I use a bunch of-- you know, as funny as it sounds pipes, PVC pipes. As a mechanical engineer the heart to me is a pump. It's a very beautifully engineered pump. It's very redundant. It's fall tolerant but it is a pump at the end of the day. So I worry about how to recreate the normal human's

blood flow in a synthetic model and then what I do is I use-- similar to your puppet strings I pull and push parts of the heart at a predetermined fashion mechanically that I know. And then I investigate what happens to the fluid inside. And the cool part about this is that to translate this to the clinical realm I need to have some sort of bridge to the patient bedside. So we are collaborating with Doctor Edward Martin at Oklahoma Heart Institute in Tulsa and he has graciously allowed us to use his MRI scanner after hours. To where we can actually put our-- what we call our phantom or fictitious model of the heart in the MRI scanner. Get MRI data with the sequence that they use on people like you and me which probably are not giving you the most accurate depiction of the disease, how severe it is. Except we can do the same experiments in a lab with more high speed sort of slow motion imaging of the wall with video cameras and then we can actually figure out what sequences really help to get to the diagnosis-- improve the diagnosis.

>> So when we say this is kind of like-- I'm just kind of generalizing this-- are you looking for like a piston pump kind of thing for the heart--

>> Yes.

>> Is that what you are trying to do?

>> That is really it. So the heart has some sort of pressure in the muscles that it applies to pump-- we use a pump for it that can be computer controlled. So we basically tell the pump to move back and forth. It is a piston driven pump and that basically forces the heart to move a particular way.

>> And would you miniaturize this type of device so that it can be implemented? Or how would that work? Would it work externally or internally?

>> Right so the particular-- this random is more for the physiological sort of investigation. So it is not necessarily in the device perspective yet.

>> But I mean--

>> But down the line--

>> But I mean your vision--

>> Yeah, yeah so down the line one of the things would be to improve CRT, this pace maker therapy. Can we get live sort of imaging from the patient? So one of the difficulties with this-- one of the nice things about MRI is that is very high resolution. It's beautiful images, very clean and clear, high quality images. But the problem is they cannot do this on a patient that has been with pace makers.

>> Sure.

>> Or implanted. So perhaps what we could do is get imaging data before the implantation process. Use that to design patient specifically how to do this implantation?

>> Right.

>> On a computer model and that is kind of the vision for what I'm doing. But to delve a computer model I need to have experimental model to compare and prove that the computer model is accurate.

>> Arvind Santhanakrishnan is Assistant Professor of Mechanical and Aerospace Engineering at Oklahoma State University. And we have a lot of more of his research to talk about when we return on *Oklahoma Innovations*.

[Music]

>> From Oklahoma City to Tulsa, Woodward to Lawton. This is your science and technology radio magazine, *Oklahoma Innovations* on the OCAST radio network.

>> Pancreatic cancer is the fourth leading cause of cancer deaths with a median survival range of only 6 months. As an oncologist, I see far too many families suffer from the effects of this terrible disease. We need better treatment options for patients.

>> With the support of the Oklahoma Center for the Advancement of Science and Technology, the researchers at Core Biotechnology have what they hope will eventually be a treatment, even a cure for pancreatic cancer. They have identified a protein that if blocked may prevent tumors or keep them from growing with help from OCAST and i2E the team at Core was recently awarded and SBIR Research Grant to enable them to continue their research and move closer to a treatment for pancreatic cancer. If you're a researcher or a small business in Oklahoma and are considering applying for Federal SBIR funding contact OCAST toll free at 866-265-2215 or visit us on Facebook or our website at OCAST.OK.GOV.

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>> Research and development, technology transfer and commercialization, creating high paying jobs in Oklahoma is what OCAST is all about. This is *Oklahoma Innovations* on the OCAST radio network.

[Music]

>> Thank you for joining us on this week's edition of *Oklahoma Innovations* and if you've just joined us we welcome Chad Mullen of OCAST. Who is our new co-host for the program as Tessa has been promoted and moving on to other things. And we're delighted to have him on the program doing a great job, Chad.

>> Gary, thank you for having me. Glad to be here.

>> No problem. We have an interesting guest this week, Arvind Santhanakrishnan. He is an assistant professor of mechanical and aerospace engineering at OSU and we are talking about some of the research projects going on in his division.

>> And Gary, we were talking about-- on the break, a little bit about looking at things in nature, so bio-inspired design. And Doctor can you share a little bit with us-- a little bit of the research that you are doing in that area?

>> Yeah, we've got a few different projects looking into that area of research. So one of the interesting things about biology is that, you know it's got the life timed experiment and come up with solutions that are probably going to last for a long time. And as an engineer I like to use that as sort of a guide improve design so a couple of the things we are doing right now: one project looked at the tiny-- one of the most tiniest species of insects that can fly. So these are probably smaller than the noseuums that you've probably heard of. The Gnats and all of those. So there are a quarter of a millimeter so there's--

>> Wow.

>> Probably smaller than a speck of dirt. And the interesting thing is that they can disperse across miles and miles and they're ecologically very important. Agriculture's crops are affected by them.

>> Right.

>> They can spread diseases. So from one side, you know agencies like USDA. These folks can actually gain, you know, some sort of insight into how these guys migrate and little is known. Entomologists don't understand. All they have is observational data that suggests they move. And so that is one area where bio-inspired design is sort of-- you know, you get 2 things at once. Not only do you understand what the agricultural-- how they disperse-- that sort of implications. We can also use their mechanisms to design potentially a flying vehicle that can actually be very miniaturized than what we currently have out there. So the drones that we have currently out there. They are limited by the size skills and so if you wanted to actually do a better job at different missions to increase the possibility of launching a swarm of them then we need to think about miniaturizing them. So this is one of the areas that I am interested in.

>> So how would you miniaturize a drone? That's almost-- it seems impossible--

>> Yeah.

>> Especially a tiny one.

>> So the interesting thing is, you know everybody has seen like these James Bond type of things where you hit a button and a big plane becomes a small plane.

>> Yeah.

>> A big car becomes a small car. Turns out that doesn't work, okay? So when you go from big to small-- this is something that I learned in a harsh way. I was confident getting my PhD. I thought everything worked the same way. So a big bird and an insect or dragon fly and these tiny insects, they all fly the same way. I mean why not, right? I mean they all flap. We all see that but turns out they don't. Each of them have design modifications. So the wings of these tiny insects are basically like a thread of silk with--

>> Yeah.

>> A bunch of hairs so literally there is no actual membrane-- noticeable membrane that they use to propel themselves, right? And so making this is going to be-- to the exact detail is going to be--

>> A challenge.

>> Challenging.

>> Yeah.

>> And that requires research into the materials aspect, the fabrication aspect of those things. What we are starting to do is discover what the mechanisms are right now and then hopefully we can sort of collaborate with folks that do the materials part and build something that small.

>> You know Chad maybe that is where more nanotechnology comes in to play.

>> Oh absolutely Gary. I think that more is less these days. And so-- or less is more these days I should say. Now tell us, you know as you work on the mechanical design of these things, how would-- and I'm assuming it hasn't been figured out yet but what is the thought on powering small items like this? How would that occur?

>> So that is the real challenge when it comes to miniaturization. Its batteries take up space. They are weight, you know alternative energy you know, you have to have some sort of panels or receiving elements for solar power or whatever you are trying to use. So that's really one of the significant challenges in terms of how do we get power sources to be smaller and smaller? One of the things that I did during my PhD was to use what is called plasma. So it's another state of matter so it's you take air and you ionize it. You basically create like a lighting storm if you will, discharge it and the molecules and everything basically reorganize themselves and so you can actually have a plasma-- different state of matter and that can be used to actually create jets. And these jets can be used in a flying vehicle in sort of a traditional sort of an aileron on or a rudder to move air around. So this is something that I did several years ago in Kentucky and something that I am wanting to go back to at some point. But there is all these different complexities, right? So trying to figure out how they move and then how do we build this thing? How do we power it? How do we make the-- all the little appendages very small? So there is a whole lot of layers to the problem.

>> You've actually discovered how many times a small insect flaps its wing per second. Talk about that real quick.

>> Yeah so these guys are quarter millimeters or so and they are very hard to see. And they actually flap their wings like a hummingbird so 200 plus times a second. And so if you think about imaging a speck of dirt-- smaller than a speck of dirt moving that fast and trying to resolve how the wings move it requires a lot of-- new hardware. Very expensive new hardware and so we collaborate with the biologist in North Carolina who caught these insects and I was there with the student when he caught these insects. We actually used very-- 4,000 frames a second-- very high speed cameras.

>> Wow.

>> 2 or 3 of them and then we got, you know a magnifying lens to create a very powerful light to be able to see this tiny, little creature. And it was incredibly hard.

>> I'm sure.

>> You know after a whole summer we've got maybe 2 or 3 videos that show what is going on.

>> Wow.

>> To some level of clarity.

>> Fascinating. Fascinating.

>> And Gary, I am going to just switch gears for just a second-- something you brought up is collaborating with the hospital and told us at the heart hospital collaborating with the University of North Carolina. How would-- you know, you've been in research for some time now. How has-- how important has collaboration with industry in other research facilities-- how important has that become? Especially in light of some of the funding challenges we're incurring.

>> Yeah, it's a great question. I think collaboration is wonderful. It's not just because of the funding climate-- to secure more money to be able to do all these nice projects but I think generally collaboration helps you intellectually grow. You get-- the best ideas sometimes come from the people that are not experts in the field and so that is something that has always been my philosophy is to listen to people that probably don't have the same degrees as me or have the same background as me but potentially they can be the most valuable team member. And so collaborating with the industry folks for example gives me a little bit sense of practicality-- of what solutions can be translated. So actually makes-- can drive research very hard and fast but research that takes too long to manifest into something society could use.

>> Sure.

>> And so industry helps to sort of keep that reality, sanity check in perspective because they are fighting out there. They're worried about getting the product market.

>> Yeah.

>> At the end of the day and as far as the other discipline is concerned I am an engineer I can understand biology to the extent that I can but not somebody that makes their living being a biologist. And same way, cardiologist is not the same as somebody that takes up a book like me and understands cardiology. They see people in real life--

>> Right.

>> And so their input is extremely critical. Very honestly none of what I am doing would be able to go as far as it could without collaboration. So it's just as equally important as what my group is doing.

>> But that also-- that also sets the goals of the direction where-- if you go on your research. In the couple of minutes we have left in this break I wanted to transition into crayfish as how another natural creature that is motivating you to study something like a crayfish for underwater drone vehicle development. Talk about that.

>> Yeah so crayfish all over the place. Everybody in Oklahoma knows this. They probably think they're delicious.

>> Yeah.

>> I took a different turn with it and I have been working with these people-- my collaborators who are mathematicians in the University of California, Davis. They actually discovered that crayfish-- the way they paddle-- if you watch a baby crayfish that is swimming they actually

paddle their legs from the tail to the head and they move back and forth. So it's 4, 5 limbs that they paddle. And so it turns out they do this sort of the football stadium wave. They don't paddle like the rowing team in the Olympics or whatever. They don't paddle everythi-- all the legs at the same time.

>> They don't paddle like that--

>> They actually have some sort of delay.

>> They don't paddle like a turtle either--

>> No.

>> Right?

>> No. And so what is curious is that they were able to show that it is a-- that little delay that helps them to swim more efficiently. And so what they couldn't do and what I am trying to do is to make a bigger and bigger crayfish. See where this mechanism breaks down. Nature is interesting in that it actually picks and chooses different mechanisms. A bug flaps its wing, a spider balloons and goes through these nets.

>> Yeah.

>> A crayfish paddles with its limbs. The question is why? Is there a mechanical reason why it's happening? Is it driven to like-- you know optimize their performance?

>> Right.

>> That is a begging question that is hidden in there. And so we've made a robotic model to be able to do that.

>> That's interesting. Arvind Santhanakrishnan, assistant professor of mechanical and aerospace engineering at OSU and wow! This is fascinating stuff. We're getting a lot in here in this hour. More to come when we return on *Oklahoma Innovations*.

[Music]

>> As a police officer one of the most dangerous parts of my job is arriving on a scene where an armed suspect has barricaded himself or where we suspect some type of booby trap. We're most vulnerable when we don't know what kinds of explosives or weapons are on the other side. It could be deadly.

>> Tactical Electronics, an Oklahoma based company invents, manufactures and sells tools such as under door cameras and video fiberscopes that are used by law enforcement officer, military and counter-terrorism personnel around the globe. The tools allow areas and packages to be inspected from a safe distance which reduces the risk of injuries and death. With the support of OCAST the company is developing image recognition software that scans packages and within milliseconds identifies what's inside. OCAST is advancing science and technology that not only improves but also saves lives. For more information call OCAST toll free at 866-265-2215 or visit us on Facebook or our website at OCAST.OK.GOV.

[Music]

>> We hope you are enjoying this *Oklahoma Innovations* program this week. Fascinating stuff how mechanical and aerospace engineering can evolve into new innovations studying everything from little creatures under water to things that fly through the air. And then of course talking

about some new innovations in heart therapies. We are talking with Arvind Santhanakrishnan who is an assistant professor with the mechanical and aerospace engineering at Oklahoma State University.

>> Gary this has been-- and Doctor, thank you for being on the show. This has been really informative. You know, I think it's-- kind of reflecting on some of the things you've said, it seems like we spent the 1900's fighting nature and now we are spending the 2000's copying nature. So it's very exciting. Tell us a little bit about-- so you know in addition to your research you are a professor at OSU. You interface with a lot of students. Tell us a little bit about that and how they fit in to your world.

>> Definitely. So students are probably the most valuable chunk of everything that I do. And my lab has several PhD students, Master's students, multiple undergraduate students and even high school students. So the whole-- I try to get people involved in science from the-- however young they are. The earlier that I can get them involved I think they will stick around and do wonderful things. And so with my teaching, I try to involve my research as a part of it. So I am teaching a class at OSU right now in experimental fluid flows. And so every student gets to work on projects that actually are similar to what I am working on so they build little things, they test them: underwater, in air, you name it and they come up with ways to measure things. And so it's an exciting way to-- research sounds-- to a lay person it probably sounds a little but intimidating and it's not supposed to be that way. Research is just a way of answering questions and curiosity really at the end of the day. And so my students I treat them just as piers in the way that we all exchange ideas together and talk to each other very conversationally and come up with ways to solve a problem as a team. And not just give a student a particular project and you know, say, "You're responsible for this and you're responsible for that" because I think best ideas come when people are collectively working together.

>> Oh absolutely.

>> Because it really stimulates the passion and creativity and there is no need for negative competition anymore.

>> Have you ever had one of those moments in class where a student discovered something?

>> Of course.

>> And they come to you and go, "Oh my gosh! Look what I--" You know, can you-- tell us anything--

>> Yeah definitely. So you know the insect flight for example that we built a robotic model. It was a bunch of OSU students that built it. People from Oklahoma that built it.

>> Oh sure.

>> Right? And it was a class project. They didn't understand how difficult this was going to be. I sort of did but I never told them. [Laughs] because you know, you don't get work done if you tell them--

>> That's right.

>> How hard something is but before then they were able to program some of these motors--

>> Yeah.

>> And they'd stay up late nights working and they would come to me and they'd say, "You know what? I think I can do this. I know you didn't want this type of motion but you know, you didn't say you wanted it now. You'd say it would be nice to have it. I can do it now".

>> Yeah.

>> And so these things are exciting because it's self-discovery. I have no part in it other than just enjoying it [laughs].

>> Sure well you know what we talk on this program a lot? Is the creativity. That is the motivator and then of course have got to have a passion for it. And I think what you are doing with the students to get them involved and they get excited about something then as you said, they stay up late at night to test things. That's just awesome. Let's transition a little bit. We talked about this earlier in the program. You talked about fluid motion. Which I guess that will be a nice transition to talk about your research on studying jellyfish.

>> So like I said, I grew up near the ocean. So I have-- I brought the ocean with me to Oklahoma because I made all these small fish tanks and I am studying jellyfish. These jellyfish are basically not the kind that you commonly know and see and appreciate on TV. In many aquariums these don't swim.

>> Oh!

>> They actually live attached to the sand and they are called "Upside down" the moniker because they are literally upside down. Their tentacles point upwards towards the sunlight. Their bells-- the parts of gelatinous bells that move, they stay attached to the sand. They will swim if they have to. If we starve them they will swim to find food. But they don't prefer it. And so what is interesting is that the environment that they live in is very slow moving fluids like coral reefs or sea grass beds. So if you have-- can picture the Florida Keys that is the exact type of environment. Very shallow waters, warm and so that is where they live. And what is interesting about these environments is that it's really hard to create nutrients to move through them because typically the currents carry the nutrients in the deep ocean and so you get a healthy balance in the ecosystem. And so these organisms play a vital role in kicking up the sand as I would say in terms of being able to pull buried bacteria, nutrients in the sand and pass it to the water colony so basically creates a nice balance of the ecosystem. And what is interesting to me about studying them is that filtration is a very challenging problem when you make things smaller and slower. I worked in a project in my previous job at Georgia Tech with Children's Healthcare of Atlanta where we made a dialysis device for children and we really couldn't find a good filter for children. Because you know their blood flow rates are very slow compared to adults. So one of the things that I am hoping to understand is how they filter the water and potentially can be used to design mechanical filters--

>> Wow.

>> That could range from using in little pediatric dialysis machines to also potentially making little devices that you can put and clean up a little body of water that is stagnant. But serving a little village or town so that is the grand sort of plan.

>> Cool.

>> So I study how they pulse [phonetic]-- how they move the water around and how they catch stuff, how they filter it.

>> Well that I mean, that is absolutely amazing. We just have a few minutes left of the show today so I wanted to ask you a little bit about some of your research on vertical access wind turbines. So these are the smaller wind turbines or could be smaller, more compact. Gary I think as you are aware, you know there has been quite a debate about the wind industry in Oklahoma. Some concerns about the size, the impact on the lesser prairie chicken, flickering, all these sort of things. So what you're working on is-- may be a potential solution to the more traditional wind turbines we've seen. If you could tell us a little bit about this.

>> Yeah definitely. So vertical access wind turbines are becoming more and more important because power demands grew in cities and as a result urban power generation is a big problem. And so these wind turbines are not the typical ones you see up on hilltops. These are Oklahoma Medical Research Foundation actually has them on the rooftop. It's a wonderful place but the interesting thing about them is that they are only as big as 10 feet or 20 feet, not that big. Easier to install, easier to repair and service and you could potentially put them in your back yard if you really wanted to. In your own farm, you could do that. And the technology still is very much in the rudimentary stages as far as improving deficiencies and our understanding what happens when you put them together in a farm type of setting. So you have a bunch of turbines collectively spinning. So how do you position them to be able to get the most out of individual turbines and maximize the power generated? So these are some of the questions that we are trying to figure out right now. And we actually have a patent in the works with the Oklahoma State-- I mention disclosure office to-- basically engineer an additional attachment to a vertical access wind turbine to be able to improve the harvesting efficiency of some of these turbines.

>> Wow. Well congratulations on that! My goodness! Well, you're a busy guy. You got a lot going on in your department. Tell us a little bit about what you'd like to see as a future for the mechanical and aerospace engineering department at OSU because you've been there long enough now and you obviously with all these projects and getting special grants from OCAST of course. And now getting a patent, you've done-- you've accomplished and achieved a lot. Tell us about what your future is at OSU? What would you like to see happen in the future and with your students-- what is the goal here?

>> Yeah so the department has been amazingly helpful. The college of engineering, they've been very helpful in providing everything I needed from the first day. And so that's a big encouraging motivation for me because I don't have to hassle for anything that I need essentially. As far as the department goes, we are constantly growing and one of the things that I sort of-- I think is going to happen is that students are going to become more involved in laboratories, being able to start thinking and innovating and not just going to class work. So the traditional-- I've sort of wanted to challenge the traditional role. I carry a backpack with me all the time but that is just to look young, right? [Laughs] But students don't--

>> Yeah, yeah, yeah, yeah.

>> Right. So students don't have to just go and learn from a lecture hall anymore. They can learn amazing things from a laboratory, you know doing the work. And a healthy balance is needed. And I think that is one of the areas that I want to encourage and improve. So I am actively always recruiting undergraduate students, getting them excited.

>> That's great.

>> Putting them in project and before they know it they get excited. I mean, it's a process of creativity. You give somebody an outlet they are going to enjoy it. That doesn't matter--

>> Well you know and what we hope too and of course OCAST is a big part of this is we hope that some of these students when they graduate will go off to opportunities in Oklahoma for high paying jobs, better yet startup companies. Become their own entrepreneurs, right Chad?

>> Stay in Oklahoma.

>> Yeah.

>> That's it. That's our whole goal because it continues to diversify and build the state's economy. Arvind you've been a wonderful guest. We have got to have you back. You got some exciting project and we'd like to learn more as you continue to grow at OSU. And evolve into more mechanical and aerospace engineering projects. We are out of time. We want to thank you and Chad great job this week!

>> Gary, thank you.

>> Talk to you next time--

>> Thank you very much!

>> On *Oklahoma Innovations*. Have a good week.

[Music]

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