Tracey Peake: [00:02](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=2.26) Hello and welcome to NC state's audio abstract. I'm your host Tracey Peake. Wouldn't it be cool if we could monitor our health by just putting on a shirt? Jesse Jur, associate professor of textile engineering, Chemistry and Science at NC State thinks so. We're speaking with him today about the emerging field of smart clothing production, what it is, what benefits it may provide, and what the stumbling blocks to production may be. Welcome Jesse.

Jesse Jur: [00:28](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=28.91) Hey Tracey. How are you doing?

Tracey Peake: [00:29](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=29.9) I'm doing great. So let's get started with what is smart clothing?

Jesse Jur: [00:35](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=35.11) Yeah, so spark clothing and obviously clothing you wear, but smart is how do you make that clothing sort of responsive to your environment. Um, and then within a whole subsection of that, you could say that smart clothes, uh, would be the integration of electronics in there that enables those features of making it responsive to the environment. In terms of textile electronics, which is kind of a, what my specialty is. Uh, we actually look at how we integrate electronic devices in a very seamless way into, into textiles for sensing your bodily conditions. Um, sensing whether or not you're wearing the right clothes, uh, using different types of devices to um, to change your, um, your comfort levels. The ultimate goal is to make these garments so that the functions that are in there are imperceptible to the, to the user that's, that's, that's trying to take advantage of them

Tracey Peake: [01:29](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=89.69) In the medical realm, what kinds of I guess uses would you have for these garments?

Jesse Jur: [01:35](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=95.78) Well, we're talking about vitals monitoring and all of the other things that help understand what's what the humans going through to get to those vital signs. So for example, the activity levels are definitely an important feature. Core body temperature, which you can actually start to which people have studied, how to get your core body temperature or basically like when you are measuring your, the temperature. If you feel like you're sick, it's the same type process that you actually put a thermometer in your mouth. Well they actually can get that through your heart beat data, uh, that you can collect or what is referred to as electrocardiogram measurements. Furthermore, you can start to understand your muscle activity and your workload associated with the different activities that you're doing. And if you understand that whole picture, then you can start to make some really kind of key assessments on a person.

Tracey Peake: [02:23](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=143.99) So let's talk a little bit more specifically about what your research focuses on.

Jesse Jur: [02:27](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=147.53) There's first of all, the different methods on how you actually design the garment to make it really functional. These can be very complex garments. A lot of times I like to, you know, kind of maybe put a visual in your mind is to think about those really tight fitting garments that people that at that athletes wear, well this is kind of the type of garment that we need as well. Once you start putting sensors at different locations and these sensors, which we'll get into in a second, we actually print onto the textile or embed into the textile themselves. A lot of times when your moving around that will, that will change the electrode's position on your body and it will result in noise and data that that does not allow for an analysis of the data that you're getting.

Jesse Jur: [03:13](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=193.871) One of the common tests that we refer to is the hand wave test. So think about raising your hand and waving to someone that will, if you have your electrodes that are kind of around your chest, your shirt moves typically up with your arm as you're moving up. So what we have to do is we have to design the garment in order to allow your arm to move freely but not move the devices that you have on your arm that are trying to collect that critical data.

Tracey Peake: [03:37](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=217.99) Let's talk a little bit more about how that, how you do that.

Jesse Jur: [03:40](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=220.6) We have a textile and we can actually print electronic materials on that textile and then we try to embed materials around that in order to make it launderable. And so those are the basic things. That's how, that's our starting point. Now as we start to put those onto garments, we have to route these sensors on the, on the garment to basically a central hub, this removable puck that has the electronics in it.

Jesse Jur: [04:03](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=243.61) That's actually one of the main advantages of textile electronics is that you can have sensors located all around your body, uh, or all around like a shirt or your pants and you can route all of those to one central location. And so that could be sort of like your data collection area. Then you can use, then you just have one communication channel or hookup channel to your cell phone to collect all of that data to the external world. And so we're trying to eliminate that user burden just by having just that one electronic spot for communication to happen to the outside world. It turns out that this actually reduces the total energy consumption. And so all in all, it reduces a total user burden for the user if it's embedded in textile.

Tracey Peake: [04:50](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=290.68) So the little puck is basically the battery that powers the electronics, right? Because we haven't figured out a way to power them by our own body heat.

Jesse Jur: [04:58](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=298.54) Well that's kind of the, it's one of the next things that we're doing. So, um, one, uh, a lot of the research that we do on biomedical garments is out of a center that we have at NC state called ASSIST. Uh, which stands for the advanced self powered systems integrated sensors and technologies. And this is a national science foundation, uh, nanosystems engineering research center. What we've been able to develop within the centers, a number of platforms by which to apply sensors into a wearable, a so that a person can wear it. But we've also been trying to understand, well, what are the strategies to reduce the total amount of power? And in some cases, reducing the amount of power so far is that you could actually harvest that power from your body. So you never even have a battery.

Tracey Peake: [05:40](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=340.78) That'd be great.

Jesse Jur: [05:41](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=341.26) Um, or, or it helps support a battery and make it makes it last longer.

Tracey Peake: [05:45](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=345.88) And that kind of leads me into the next question, which is, you know, the flood or some of these other pie in the sky smart clothing ideas that we have on the drawing board?

Jesse Jur: [05:57](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=357.77) Going back to the manufacturing, I'll start there. We've been looking at again, how do you, how do you design your garments so that you can raise your arm and the sensors don't move around with it to create that noise. One of the strategies that we are looking at is how do you take a 3D body scan of a person, take that information, develop that CAD program, and then plug it into a machine and then it actually print out the garment for you. And so you can actually have this sort of like maybe even in the back of the doctor's office where you have that, where you garment is produced. Maybe even by the time you leave your doctor's office. That sounds pretty crazy.

Jesse Jur: [06:39](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=399.69) Uh, so that's from the, I would say the automation side of things. The second thing that we're, we're probably, uh, what's, what's kind of interesting that we're working on is improving or understanding and then well, understanding thermal comfort and then finding ways to improve it in such a way that it's a matter of just adjusting your or making the adjustments on your cell phone and things within your clothing actually change. So we've been working, uh, for the past couple of years on, on cooling devices at that you can also well, uh, on a device called a Peltier cooling device. Um, and they usually use this in the microelectronics industry. They're typically really hard devices, something that's about a stiff as your cell phone. And what we've been trying to do is make this into a form factor that is, um, or do you remember those old are the mouse pads that are like the floppy, floppy mouse pads.

Jesse Jur: [07:37](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=457.4) Those are made out of foam based materials. And we've been, we've been redesigning those hard devices into, soft devices. So now you can actually start to put this into clothing. And that's a really exciting thing for us.

Tracey Peake: [07:50](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=470.63) As anyone who's ever worked in an office building will tell you, that would be excellent. No one is ever happy with the office temperature.

Jesse Jur: [07:58](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=478.4) That actually produces a lot of different economic trade offs for enticing people to use these types of garments. And so just like you have home credits that you, that you have for installing solar panels, eventually you might, if you're harvesting power from your body or you're able to wear things that reduce the amount of energy that's being consumed there is this, this does start to allow to have the conversation that you could start to get sort of credits for things that you wear, or you could start getting cost reductions on these, what would be higher, what would be expensive garments, but they're lower cost to you because you're using them.

Tracey Peake: [08:38](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=518.87) So I'd get my wearable wardrobe garment discount because I can keep my home thermostat on like 52 and then my shirt at a nice comfortable 75.

Jesse Jur: [08:50](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=530.45) Exactly. Yeah, it would be. It would be pretty amazing. Um, but you know, the, uh, of course these are, these are things that are way out there. Um, but it's, if we're not asking the questions now, then you know, we can't start thinking about the things that could happen in the future.

Tracey Peake: [09:05](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=545.06) Well, and on a related note, what is the most interesting or surprising thing that you've discovered?

Jesse Jur: [09:11](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=551.67) I would have to say it is the creativity of the students that we have here at NC state. I run a research group called Next, which stands for nano extended textiles. Primarily what we do is we work on, you know, the materials and processes to make these garments, um, or to embed electronics in textiles.

Jesse Jur: [09:31](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=571.95) But then we also have another side of the group that does product development for industry. And so we have a, I have this Ph.D. side and this phd team that's, that's really innovative and creative and I have this product development team that's outward facing towards industry and it takes the, the multidisciplinary creativity within a team like that to all work together. In order to get that, to go from that, you know, basic research foundation out to a commercialized technology.

Tracey Peake: [10:03](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=603.69) What is an example of one of the coolest ideas they've come up with?

Jesse Jur: [10:07](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=607.83) Oh Man. Right now we are, um, so we, every Thursday we have at our group meeting, um, uh, for about the past year we've been working on mind mapping an ideation sessions around these different fields. Um, and one of the, one of the more exciting fields that I think that we're kind of getting into or don't really talk about a whole lot, but it's, it's kind of way out there is, uh, is how to generate, um, how to generate these wearable electronics, uh, for our smart garments for the E-sports industry.

Jesse Jur: [10:46](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=646.82) Um, so these would be things like haptic feedback sensors. So there's a company, a couple of, I always show this in my presentations, there was a company called, weacts that had made a platform that had haptic feedback sensors in there basically like vibration motors, so that when your favorite football player got hit, you could actually feel it. And I always joked about and I was like, you know, that sounds like a, that sounds like a really ridiculous product and everybody always laughs whenever I give it. However, um, uh, there's a company called Cute Circuits that created the same type of garment that was made for people that are, that are deaf, and they have vibration motors in there that respond to the, to an orchestra. And so they can actually feel the, um, the music. Well, a lot of those same types of feedback mechanisms could be used in a lot of different other industries. And one of the things that we're looking at is, is, is with video games and E-sports, which is obviously one of the, one of the largest growing industries, or at least entertainment industries and spaces, uh, globally. And of course we have one of the leading programs for this here at NC state.

Tracey Peake: [11:59](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=719.56) Well, it's interesting because it's like if you saw the movie ready player one, did you see it?

Jesse Jur: [12:03](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=723.61) I did, yeah.

Tracey Peake: [12:04](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=724.301) Okay. So those outfits that they wore the same kind of thing. Exactly, yeah. So it'd be Ready Player One-ville, here we come. Thank you so much for being here, Jesse.

Jesse Jur: [12:12](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=732.37) No problem. Thank you.

Tracey Peake: [12:13](https://www.temi.com/editor/t/KF3fG00cdgIJWd1MZGXZwuod6sgXn3ivr4eUWN_QHB60RhABv3fuJwXBKTZwqtul7YLovQR_1kmJVVpB08n4N3NDwSU?loadFrom=SharedLink&ts=733.52) I am looking very forward to some of these new outfits in the future, especially the ones that will help me stay cooler. We've been speaking with Jesse Jur, associate professor of textile engineering, chemistry and science at NC state. My name is Tracey Peake. Thank you for listening to audio abstract.