Becky Stern

Director of Wearable Electronics
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*When it comes to wearable technology, **Becky Stern** is paving the way. Her work at Adafruit Industries (adafruit.com) melds wearables and fabric with the world of electronics. As the director of Wearable Electronics, Becky produces a lot of unique wearable projects, which she shares with the open hardware community. With the video and web content that she creates, Becky enables hackers and students to learn sewing and electronics in fun and innovative ways.*

Steven Osborn: Hey, Becky. What got you interested in making things?

Becky Stern: Well, I'm the director of wearable electronics at Adafruit Industries. I make tutorial projects incorporating electronics components into wearable things, like scarves and bags. I teach people how to make them with videos online. So it's kind of an amalgamation of a lot of different things that I like to make.

At a young age, I was making a lot of videos. I liked to edit videos and film things. I learned video editing at a pretty young age. At an even younger age, I learned to make crafts. My parents are both very crafty in various ways. My dad loves to cook, and my mom does knitting, quilting, embroidery, and all kinds of sewing. So I learned those things from them. I got my first sewing machine when I was thirteen. I filmed my parents framing an addition on our house, when I was five-and-a-half, with our giant VHS video camera. So I started those things very young.

Then in college, I got into electronics. I went to Parsons School of Design here in New York City and started hacking toys and making my own toys with simple electronics inside. For instance, I made a glowing plush nightlight. So I got really interested in playing with LEDs and basic programming. That's about the time that Arduino came out, when I was in college, and I started making fun Internet toys.

From there, I was always putting my projects online and sharing tutorials, because I liked to write. My father's a lifelong newspaper editor. So I would share all these tutorials about how to make these projects that I was doing for school. I was doing documentation on our class blogs and on Instructables. My projects kept getting posted on *Make* magazine's blog until I eventually got offered a job there writing for their blog and ultimately making videos about various DIY projects related to crafts or electronics, or things like that. That's how I got here, I guess. I've always been interested in fashion and making things by hand, and teaching other people how to do things in open source, and making weird electronics gadgets.

Osborn: So you made an interesting transition from crafts to electronics, which is pretty unique. Would you say your parents inspired you to go down this route or did you always have a natural curiosity for things?

Stern: They were always teaching me how to do things and had an interest in showing me the things that they were interested in doing and making. They just happened to be making a lot of things. They did encourage me and buy me all kinds of tools. A few Christmases in a row, I was on a big baking kick, and so I got a Kitchen Aid mixer and every cookie cutter there was. I was encouraged to make a lot of things. Then my dad always liked to use my gear. My mom gave me half of her knitting needle collection because she had three of every kind. And I got a sewing machine for my thirteenth birthday.

Osborn: So what got you interested in electronics?

Stern: I was in school and I wanted to try out whatever was going on. I liked exploring new things I hadn't tried before. I took a class at Parsons called Making Wireless Toys. It was by Professor Yury Gitman, a toy designer here in New York, an electronics toy designer.

We were given these interesting challenges like, for example, to make a plush nightlight or a simple switch. We figured out ways to do those things with very limited knowledge—basically just a circuit with an LED and a battery.

I like to make—reconstruct—3D objects, so making plush toys is a natural extension of that. I used to clone my Beanie Babies when I was a little kid. I would take the duck, and I would figure out what shape the fabric needed to be to make a new duck out of new fabric. So it was something new. It seemed fun and new.

We started out programming PIC[1] chips. It seemed hard. Before that, I had only coded web sites in HTML, and so being able to code physical actions and make sounds and lights happen based on sensors seemed really fun and exciting. There was a support group at Parsons—lots of students and teachers who were also interested in that kind of stuff and helping get new ideas. It was a really fertile, creative environment there. It was a good time.

Osborn: When you were getting started, can you think back to any interesting projects or things you saw other people doing that were interesting or that inspired you?

Stern: There were a lot of professors' projects that inspired me, like a giant plush pillow that has a beating heart inside it with a simulation of a beating heart with vibrating motors. It was a toy for relaxation. You can hug it like a pillow and it can start to affect your own heart rate. That's interesting because it's a commercial product, but it's a boutique commercial product.

Seeing my professors as entrepreneurs was really inspiring. It was before Kickstarter and all that stuff, so launching your own product and sourcing manufacturing and being actually able to ship things was really interesting to me. I felt that way about publishing. I liked to publish lots of things as often as possible just to get practice and feedback from community. I was really inspired by the people that I met on the Internet who were sharing, who were really interested in my projects.

That's how I got hooked up in the FAT lab, Free Art and Technology group that I'm a part of. It's a bunch of people who know each other from Parsons or maybe Eyebeam, which is an art and technology center here in New York that has residencies. So it was a natural extension of the Graffiti Research Lab, if you've ever heard of that, which explores open-source culture and open-source technology for interacting with the spaces around you. The FAT lab is this international group of twenty-five artists basically connected over an e-mail list who all have a similar sense of humor and publish projects on a collective web site that we might not be able to publish elsewhere.

I met a lot of my friends who are in FAT at school, so after we weren't together anymore, we still wanted a way to express ourselves, even outside of our professional careers, either as artists, or writers, or scientists, or graffiti writers. We had a place where we could kind of get our jollies in a specific way. We just had a really cool retrospective show at Eyebeam not too long ago, back in April. So that kind of started when I was in college, and I'm glad to still be working with those people today.

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[1] www.microchip.com/pic/

Osborn: All of these groups you've mentioned are based out of New York. Is that right?

Stern: The FAT lab is all over. We have a lot of members in New York, and then some in California and all over Europe—Germany, Sweden.

Osborn: I just asked because there seems to be a very dense amount of maker culture in New York.

Stern: That's true.

Osborn: In the software world, the start-ups that come out of New York are more financial or enterprise, and not usually the grassroots-type start-ups. But in the hardware world, it's becoming a hub of innovation. It's not quite Shenzhen, but it's as close as I think you can be in the United States that is not Silicon Valley, where people seem to almost believe all technical innovation comes from.

Stern: Sure. There's lots of businesses we've seen come through and get funding, and have different business models. At Adafruit, we're buddies with a lot of them, and we all support each other and hang out. It is a really fun community to be a part of.

Osborn: I guess the question in all that is why do you think that is? How do you think that came to be? Is Parsons and FAT lab a big part of that?

Stern: I think it's because New York makes media. New York is a media town with a lot of advertising and TV and movies. So when we make hardware, whatever we choose to make, we are able to communicate effectively to a broad audience. The Internet really spreads messages fast. So I'm going to say it's because we're good at producing media. But really, it has started to have its own gravitational pull. Lots of makers are inspired by local New York businesses. There's a lot of entrepreneurial history in New York, not just in tech. Then we see more businesses popping up because they see that it's possible to get funding and to grow, and to make a lot of great stuff on Kickstarter, for example. The Internet is helping that happen too. They're here also, by the way.

Osborn: What's that?

Stern: Kickstarter is in New York too.

Osborn: Well, I guess I can't say all cool software start-ups are on the West Coast anymore.

Stern: Social software start-ups.

Osborn: It's an odd environment when you go to the Silicon Valley, and you're in a coffee shop and everybody's having a conversation about his or her company's valuation.

Stern: I know.

Osborn: It sounds like there's a private mailing list maybe for you and some friends who have kept in touch and do new maker things, but what if I'm just average Joe and I don't know anything about e-textiles or maybe I know just enough to know that I want to get started or build some project, but I'm stuck? How do I find somebody or some group or people to share my passion to learn?

Stern: There are lots of databases for getting in touch with local groups online. There's a hackerspaces list, a wiki, where everybody lists all their hackerspace info so you can find places near you and then join up with their lists. We publish a new wearables tutorial every single week at Adafruit, and that's a complete tutorial, step by step, and a video with all the tools, supplies, and techniques you need to build a project. Then we have forums where people who are building a project can post up if they're having trouble, what their particular symptoms are. Or they can post their finished projects.

I'm a bit of an inside type. I don't necessarily go out and join physical groups or go and craft with others. I was never a member of any knitting circles. So I really found a community online for the stuff I was making. And although I had a local community at Parsons at the time, that wasn't permanent. I was really connecting more with people on the Internet who were sharing my vision because I was at school with a diverse group of students who were focused on lots of different things, not just physical computing and putting LEDs in plush toys, so they didn't always get it. I liked to find people who did online.

I think if you know just enough to know that you're interested in getting started, you can look through the Adafruit Learning site at learn.adafruit.com. There are so many tutorials for not only the wearables projects that I write, but also Raspberry Pi projects and basic Arduino projects, and also really fun Halloween costumes at all skill levels. We pride ourselves on having the best documentation possible, with very clear photos.

We try to make mistakes for everybody first, and show how to avoid them so they can have a fun time making projects. Then they're confident to go build more. Then we provide a forum for people to show off their projects every week on Google+. So Google+ has these cool hangouts on air, where you and up to ten people can all join in on a video conversation online. We think it's a really great forum for a show-and-tell. So people show up and they show off their electronics projects, and we all talk about them. It's a really fun community to be a part of, and people can ask questions, and you feel like you have a community there online.

Osborn: Awesome. I've asked that question to a number of people, and Adafruit Learning System has come up more than once. I think you are doing some great things with that. It seems to be the most concise and well-thought-out collection of resources available. There are a lot of tutorials on the web

that are like, "Here's some code that doesn't compile anymore and a schematic I drew on the back of a napkin. You should be able to figure it out."

Stern: We're not immune to those symptoms either, but we try to keep things updated.

Osborn: I guess my point is, for a lot of people who are really beginning, even if they find some resources online, they still end up overwhelmed. It's just kind of deflating. I think you guys do a great job of having not just low-level projects, where people can blink an LED, but then go and build some confidence, which is great.

Stern: Well, thank you for saying so.

Osborn: It wasn't just me, I promise you. So tell me about some of your favorite projects or a wacky project that you've built that maybe got some attention—or that you are just proud of.

Stern: Well, lately we've been doing some really great FLORA projects. FLORA is our Arduino-compatible wearables platform that you can easily sew into clothes and other things. It's round and flat, and has these big pads for connecting stainless steel thread, which we use to compose most of the circuits. So recently we made a skirt that lights up when you dance. It has an accelerometer in it. It senses movement, and when it detects movement above an adjustable threshold, it tells the LEDs that are in it to flash in whatever color.

We really like playing with and modding things that people already have or can find on a rack in their clothing store today to make these projects. So we take some skirts that have an overlay kind of thing. One was a sheer overlay on top of a solid-color skirt and another one was a laser-cut overlay over a slip, so this gave us a substrate on which to compose the circuit that was then diffused through a different type of fabric. With the laser-cut one, you can see the light coming out behind the cutout design.

It's really fun to play with aesthetics and technology in this way, and kind of ignite some kind of passion in people who might otherwise not have been drawn to electronics. So they might like the way it looks and want to wear that to prom, and so they decide to make their own light-up dress based on their interest from a different place. So that's the Sparkle Skirt. I think it's really cool. Teenagers like that one.

We hope we can draw in a wider audience of people to get interested in technology, because we want people to learn programming languages in school. And we want them to learn how to write the systems that control the world around us and control our ultimate technological destiny. And the younger we get them started, the better.

I'm proud of boosting our number of female viewers on YouTube for electronics projects. We did a color-changing scarf. One of the FLORA sensors is a color sensor, and you point it at a thing that's a color, like your blue jeans, or an apple, or your handbag, and then lights inside the scarf change to the color of the object. So you can match your scarf to any outfit, and it's diffused through some ruffled knitting. It's both crafts and electronics. Here you can use a reclaimed sweater to make this cool scarf and embed electronics in it and have it change color. So you're learning a little. For the electronics nerds who want to learn the electronics, we sneak a little crafting knowledge and craft/sewing instruction to them. And then to the crafters, we sneak in a little bit of technology to achieve a desired aesthetic effect.

Osborn: I remember seeing a tie with the LEDs.

Stern: Yeah, that's a really fun project. The tie is a volume meter. It has a microphone amplifier at the very topknot of a Velcro-on-breakaway tie, and then a line of our color-changing LED pixels, and then FLORA at the bottom controlling the lights. So when you speak or music plays, the lights light up like a volume meter. It's really fun.

Osborn: I thought it was really unique. Just last week I saw the Kraftwerk video. Apparently, I'm way behind the times—like over thirty years behind. So I was like, "Oh my gosh! They just copied Kraftwerk's video."

Stern: It was inspired by the Kraftwerk.

Osborn: I was like, "Aha! I found where they got it." I thought it was just so smart. Then I realized I was probably the only one that didn't notice it to begin with.

Stern: We're good at media, and that's probably why you saw our project, but there have been lots of DIY Kraftwerk ties that have big old circuit boards inside the back of the ties, and they just weren't as media-genic or easy to construct as ours. We stand on the shoulders of giants. Sometimes we'll see great projects and work with the maker to make it its best version of itself. We're inspired by *Tron*, too, in case you didn't notice. We added a little extra color too, for sure, but that is a Kraftwerk tie.

Osborn: I think I lost some geek points there. Most people probably recognize that out of the gate.

Stern: Or not. It's all right. Recently we did a *2001: Space Odyssey* project. A colleague of mine made this little HAL replica with one of our gigantic arcade buttons that looks like the HAL light and a little papercraft stand that looks like the console. And when you press it, it talks to you. It says sound samples. It speaks to you in kind of an insulting way. It says quotes from the movie. And so many people on YouTube don't get it because they're not old enough to know the movie.

Osborn: I don't really remember that one either, but I've seen it enough in pop culture. Just like I've watched just enough Monty Python to understand the jokes. Otherwise, I get left in the dark.

Stern: Well, we all have holes, right? I'm missing all of *Doctor Who*. I've never seen it at all, ever, but do you know how many *Doctor Who* scarves I have blogged? Probably a dozen. You just have to learn that stuff. Wikipedia.

Osborn: You've made a lot of cult projects. Can you think of some other projects people have made that just blew you away or inspired you to go make something else?

Stern: We have Wearable Wednesday on the blog. Oh man, someone just posted some wearable LED suspenders. That's my project for tomorrow. It's okay. They're different than mine.

Osborn: Is that like wearing the same dress to the prom?

Stern: Kind of. These kids are definitely going to prom too. That's so funny. We all contribute to the wearables category, right? It's not just me. LED suspenders—they look great. Okay, great, they're in. So my project may be a hit tomorrow. We made these suspenders that have a Pac-Man animation running around them. That's a sneak peek for tomorrow. I'm working on that. Tuesday is my video-editing day. I spend all day quietly in front of the computer.

Osborn: That's a cool project. What about other projects people have made?

Stern: A great project that I love, that really inspired me and I haven't made something like it, of course, but the thought just like blew me away was this engagement ring with induction coil and LEDs inside it, backlighting some stones in a CNC titanium ring. When his fiancé puts her hand near the inductor—there are several of them, placed in different strategic locations— the LEDs inside her engagement ring light up.

Osborn: Wow. Is that safe? That's amazing.

Stern: Yeah, it's really fine. It's just a little LED-style thing. The craftsmanship is amazing. He CNC-ed the ring and then went through lots of iterations, and then set the stones, really tiny, and put this tiny little induction coil circuit inside the band of the ring. It looks incredible. So I thought that was super touching. He wrote a big story about making this epic project for the love of his life—"project longhaul," he called it.

Osborn: That's pretty cool. I understand the induction and wireless charges, but it still freaks me out. Even though I understand it, it's still just magic.

Stern: People are making some really cool 3D fashion these days, printing large sections of garments and then attaching them to each other. Let's see. There are also expressive wearables that are more like costumes than functional garments.

Recently, I saw a hat that looked like it was full of light-up water. A Japanese woman made a cap with LEDs all over it. When she moves her head, the LEDs—it has an accelerometer or a gyroscope that senses the position of the head—make it look like it's filled up with a sloshing around fluid because it knows which way is up. It looks like a bubble level, but out of lights. It's a very attractive and creative use of technology that's really just for the visual effect alone. We're seeing lots of celebrities pick up couture wearables made just for them. U2 and OK Go had these video jackets that either say their logos or react to the show. It's really fun to be able to bridge the gap between these amazing things that are made in complete secrecy for celebrity clients for thousands and thousands of dollars to a project that you could make—to be able to think that you could make that same look at home with products and projects that you make by looking at Adafruit stuff. So we see a lot of customer projects that are like riffs on our own tutorials.

Osborn: I've lost count of how many *Iron Man* arc reactors I've seen.

Stern: Yeah. There are some cool GPS shoes. I've always wanted to do shoe projects, but I don't know how to actually make shoes and there are a lot of specialized tools and equipment. Somebody made these really cool shoes, worked with a shoemaker to put GPS and LEDs in the shoes while it was being made so you could run the traces under the sole, and that kind of thing. They have lights in the toes and are beautifully crafted. They are supposed to be inspired by *The Wizard of Oz*, so when you click your heels together three times, they show you which way is home.

Osborn: That's pretty awesome. I saw some 3D-printed shoes the other day, and I was like, "Oh, that's cool," and then I realized they were basically 3D-printed Crocs. I was like, "We can do better, people!"

Stern: I know, come on. But, no, these are beautiful wingtips.

Osborn: Out of college, you worked at *Make* for a while?

Stern: Well, I went to grad school first in Arizona. I dropped out of a PhD program, and I dropped out of an MFA program, and then I moved back to New York. During that time, I was working at *Make* freelance and I kept doing more and more stuff for them that, by the time I moved back to New York, I was working full-time for them remotely.

Osborn: So what drew you into Adafruit? Was it just that you wanted to be back in New York? Or that you wanted to work for them?

Stern: I wanted to work for them. So the creative director at Adafruit, Phil Torrone, is partners with Limor Fried. He was the senior editor at *Make* magazine for a long time. He is the one who offered me the job at *Make* in the first place and was my boss there for a while, for a long time, until he stepped down to only editor-at-large to go help Limor run Adafruit. So I stayed at

Make for a while, and I was their senior video producer. My specialty was wearable electronics.

Oftentimes, my project would use a lot of Adafruit gear and *Make* sells a lot of Adafruit gear in their e-commerce store, the Maker Shed. My job description didn't change a whole lot when I came over to Adafruit, believe it or not. I was still making tutorial projects about wearable electronics, but just in a more direct way. So really, I just did what I wanted to do. I knew they were developing FLORA and they brought me on as director of wearables to sort of spearhead projects that people would make with the FLORA, and to help work on it late in its development there.

Osborn: There seems to be a lot of interest lately—I think it's more buzzword—in the whole "Internet of Things." I was wondering if you've seen some projects that are interesting or that incorporated some wireless technology or biosensing that is interesting?

Stern: So my favorite biosensing Internet of Things project is the chair that tweets when you fart.

Osborn: Of course.

Stern: That's by my friend Randy Sarafan, who works at Instructables and is also a member of the FAT. He put the methane sensor in the chair and the Arduino in the XBee and the other part of the XBee that connects to the computer and used the Twitter API, and all that kind of stuff. Of course, there are other ones, old-school ones like the Botanicals, the plant that used to call you on the phone, but then ultimately turned out a tweet to let you know that it needed water.

Osborn: I remember something about the chair. I thought it would be really awful. And if you could deploy a whole stadium full, it would either be so embarrassing that you would have to leave immediately or it would become this sort of contest.

Stern: Come on. I don't think that one fart in the stadium—if it were being done with everyone, you're part of a collective of farts. You know, everybody farts. And you can't say that if there's a stadium full of people that it's not going to happen. So I think it would quickly become a contest. Are you kidding? There's beer and hot dogs involved. Thanks for the project idea.

Osborn: I guess that was my bigger fear—that something like that would happen.

Stern: I think they're going to do it just for that. If there's going to be another reason to put a methane sensor in a chair, make that be the fun side effect.

Osborn: Oh man, I don't want to take that any further.

Stern: You might have seen Internet of Things printers. We have one for Raspberry Pi and Arduino. Those are really fun, just little a receipt printer that prints out whatever you want—like the weather. It's really fun when it's just sitting on your desk and it finds a tweet about you and prints it out. So instead of having to check my tabs with all of my Twitter tools in it or whatever, it just sort of prints them all out. That can be fun.

Osborn: So let's see. There's the Internet of Things. There's 3D printing. You do a lot of work with wearable technologies. Is there any other vertical or category that you think is interesting or you've seen starting to take notice lately?

Stern: There is Arduino and Raspberry Pi stuff. The Raspberry Pi stuff, we know it sells very well, so we know a lot of people are interested in making projects with it and we offer lots of cool accessories to extend the Raspberry Pi. I think we're seeing a lot more single-board Linux computers, right? Beagle Bone just came out with a new version. Everybody wants to make this kind of stuff so people can do more, so that the Linux programmers can finally get into physical computing. It's no longer just the electronics and electrical engineers. You can really come at it from a programming standpoint and not much else. It makes them really powerful and cool—Internet-connected or just computationally complex projects with cameras, and USB devices, and Bluetooth, and all that stuff. I'm more of the basic electronics camp because I come from this entire other, sort of crafty side. And I do know a little bit of programming. I'm more into graphics programming, so big matrix displays. I never did a whole lot of Internet communication coding.

Osborn: I know you guys are a big proponent of open hardware. Do you use a standard license for your hardware, or is it just kind of whatever fits the project?

Stern: There are many parts of a hardware project. It's comprised of many layers. I'm sure you've heard that one before. And we do have some consistency across the things we release. For our board files—which are like an image if you know CAD files—are distributed under a creative commons attribution share license. We don't bar commercial use of producing our boards, but we do enforce our trademark. So if people want to print their own versions of the PCBs we make, they can. And they can sell them, but they can't have our logo on them.

Osborn: Is the schematic underneath the same license?

Stern: Whatever licenses we use, we use pretty consistent licenses. Like for code, we'll use one license, and for image things, we'll use another license. And usually, we allow people to redistribute our work commercially, provided they aren't infringing our trademark—because in a hacker space, they might want to etch their own boards. They want to be able to make their own boarduino or whatever with one of our products that we released the schematics and circuit board files for, so that they can learn from the process and have a fun time.

Osborn: The only reason I ask about the schematic is because I've heard different things about how the board file can be considered a work of art, whereas a schematic is considered a technical drawing. So maybe the same license doesn't really work well for both.

Stern: Right. That's why we release it as creative commons. We have a suite of licenses for all our different kinds of intellectual property. You know that fashion designs can't be copyrighted either, so that turns into an interesting part of my job.

Osborn: I didn't really think about that.

Stern: We like to release as much as we can and as openly as possible, and we try to use licenses that are appropriate for the media that we're distributing.

Osborn: Well, good stuff to keep in mind. It seems like the open hardware space is still pretty young and it will probably take some time to figure these things out. Adafruit is certainly doing their part to share with and build a community around hardware.