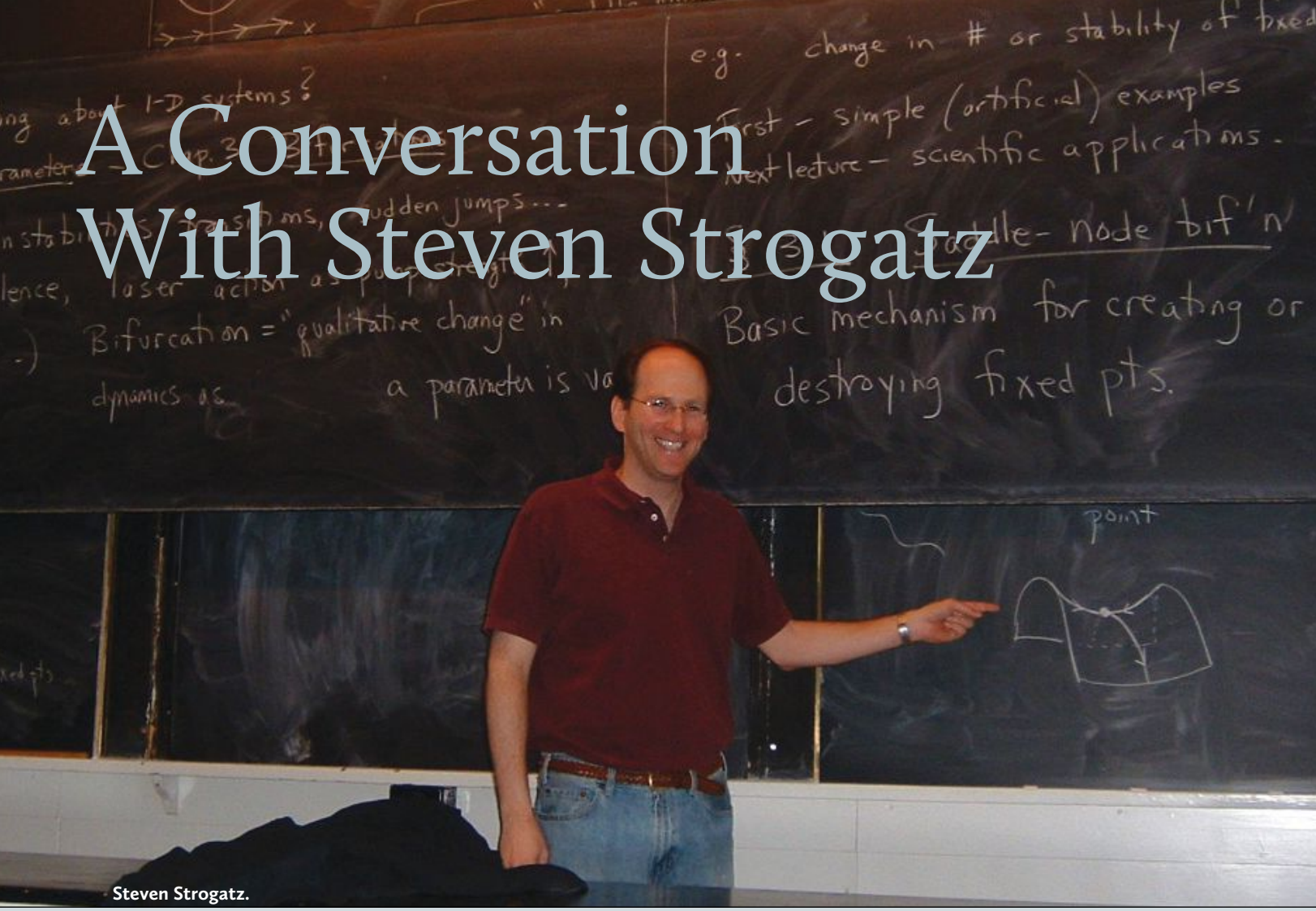
A Conversation With Steven Strogatz



Steven Strogatz.

Patrick Honner

For a mathematician, Steven Strogatz really gets around. Whether it's his popular *New York Times* series, his highly regarded books, his numerous appearances on RadioLab, or his frequent public lectures, Strogatz is out there, spreading the word about the wonders of mathematics. And the mathematical community could not have a better ambassador.

Steven Strogatz is the Jacob Gould Schurman Professor of Applied Mathematics at Cornell University. He studied at Princeton, Cambridge, and Harvard and taught at MIT before moving to Cornell in 1994. He is a renowned teacher and one of the world's most highly cited mathematicians. His honors include a Presidential Young Investigator Award, MIT's highest teaching prize, a lifetime achievement award for the communication of mathematics to the general public, and membership in the American Academy of Arts and Sciences. He is the author of several books, including *Nonlinear Dynamics and Chaos*; *Sync*; *The Calculus of Friendship*; and his latest, *The Joy of x*, which won the MAA's 2014 Euler Book Prize.

On top of being a prolific mathematician, author, and science communicator, Strogatz is a fun person to chat with. He recently took some time from his busy schedule to talk about mathematics, technology, education, and everything in between with Patrick Honner, a math teacher at Brooklyn Technical High School.

Patrick Honner: What kind of mathematician are you?
Steven Strogatz: I'm an applied mathematician. I work in differential equations, dynamical systems, and network theory, and I apply these and other mathematical ideas in a wide range of areas, like physics, biology, and the social sciences.
PH: You've recently taught differential equations and complex analysis at Cornell. What else do you teach?
SS: I teach all the way up and down the curriculum, from courses for freshmen to advanced graduate courses.

PH: What's your favorite course to teach?
SS: I like differential equations very much. It's got a lot of mathematical substance, a lot of great applications, and the people who take it are usually pretty into math. It's often sophomores, juniors, or whiz kid freshmen who are seriously interested in math and its applications. There's something for everyone in this course—but there is in all of math if it's approached the right way.
PH: You basically have a second successful career as a writer. How do you find the time and energy to do both things?
SS: It is hard to find time. I don't write at all times. Sometimes I have a writing project, and other times I'm recuperating from a writing project.

On the days that I'm writing a column for the *New York Times* or working on a book, I have a system. I force myself to keep my mornings open during the week as much as I can, because I write best in the morning. So for a few hours, say from nine o'clock to lunchtime, I won't check my email, I won't answer my phone, and I'll go to a place where people can't find me—like a library or up in my attic where the phone doesn't work.

And then I don't expect to do very much. In those three hours, I'm just going to fool around. I have to tell myself "I'm going to produce garbage," because if I tell myself "I'm going to produce something good," it feels very stressful, and I often can't do anything.
PH: Have you always thought of yourself as a writer? Did you write as a young person?
SS: I didn't see myself as a writer then, and I still don't now. I often smile when people act like I'm a writer, because I don't think I know exactly what I'm doing. In high school I certainly didn't understand how to write very well.

But there was one teacher who made a big difference: Mrs. Archibald. She used to write detailed corrections on my paper in red ink. It was so concrete and specific; I learned so much from her so quickly. I would take courses from her that I wasn't interested in, just because she was teaching them.
PH: Do you see writing and teaching as similar? Was writing *The Joy of x* like teaching? Or was it just writing? You're doing both, I guess.
SS: It's all teaching. The writing I like to do, at least in *The Joy of x*, is exactly what I think of as teaching.

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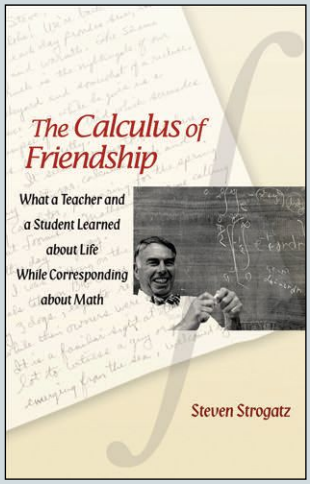

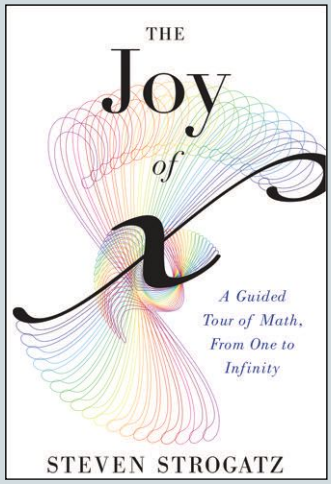

I imagined the readers as my students.

David Shipley, the editor for my *New York Times* series, told me to think about readers like him: people who are well educated and curious and smart, but who aren't comfortable with math and never saw the point of what they learned in high school. So that series in the *New York Times*, which ultimately became *The Joy of x*, was writing in the service of teaching.
PH: Your friendship with Alan Alda has had a profound impact on your writing career. He famously played a role in the writing of *The Joy of x*, right?
SS: Right. When I had to visualize the reader, I would visualize Alan, because we had been through this many times.

When we get together, Alan likes to talk about science. He hardly wants to talk about anything else. He wants to hear about the latest developments in the world of science. He's very knowledgeable and well read on science, but when it comes to math, he always feels like he doesn't have anything to say. He wants to understand math, but he doesn't have the background. So I try to guide him through things like Euclid's proof that there are infinitely many primes.

Having had this experience of talking about math with a dear friend who doesn't have a good math background, I realized that that's how I should approach the reader. If you think of the reader as a friend, you instinctively do everything right as a teacher. You won't be condescending. You won't assume things that the person doesn't know, because you're being sensitive. This is someone you care about. So you try to

Steven Strogatz, left, with Alan Alda.

anticipate what their questions could be. I like to think about all my teaching that way.

One of the great mistakes that a lot of teachers make is that they think, "I need to cover this material" instead of "I need to help this person who is my friend." In some sense, I sympathize: If there's a test at the end of the year, then you do have to cover a certain amount of material. You [as a high school teacher] know this better than I do.

PH: But teachers need to understand that, although they may teach a subject, ultimately they teach students.

SS: Yes, that's a very important difference.

PH: You're very active on Twitter [as @stevenstrogatz]. What do you like about it? What do you see as the potential for social networking in terms of teaching and science communication?

SS: I like Twitter a lot. I'm surprised at how much I like it. Twitter reminds me of my Uncle Jack. Uncle Jack was the kind of guy who would clip things out of the newspaper and mail them to me with a line on the top that said, "I saw this about nuclear energy. I thought you'd be interested."

PH: He was tweeting you links 40 years ago.

SS: Yeah, that's how it was done. On Twitter, I have 500 different clipping services: people suggesting things for me to read. If I follow the right people, it works. And likewise, I'm somebody else's clipping service.

There's also the conversation. It's been wonderful getting to know some teachers on Twitter—to plug in to what's going on in high schools and elementary schools. It feels like a community. We couldn't reach each other as easily otherwise. I get why they call it a social network: It *is* social.

PH: Speaking from the teacher side of things, being able to interact with mathematicians like you, John Allen Paulos, Edward Frenkel, and many others, is a powerful resource. We're sharing and getting ideas for the classroom.

SS: We have all of these different societies—for applied mathematicians, for research mathematicians, for college teachers, for high school teachers—but we're fractionalized. Twitter is a place where we can all come together.

PH: It also seems like there's been an upswing in quality science communication, and Twitter is a place you can find it.

SS: Yes, it is. It's the golden age of science communication. There used to be a time that if you wanted to read about math, it seemed like the only resources were Martin Gardner in *Scientific American* and Ivars Peterson in *Science News*. But now, every day there's good stuff to read, and there are a lot of great young writers writing for online magazines. I'm learning a lot; it's fantastic.

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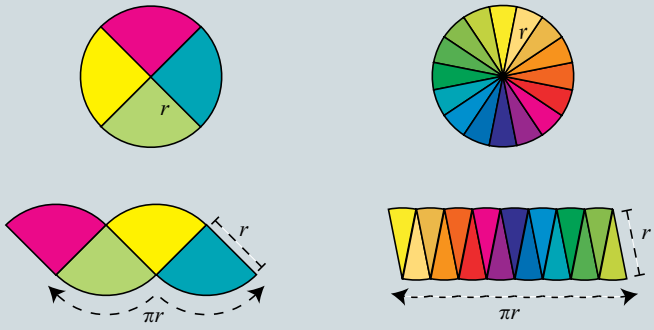
PH: You were recently quoted in a piece about the beauty of math. What's your go-to story to convince someone that math is beautiful?

SS: I usually show the argument about the area of a circle that goes back to Archimedes. By slicing the circle into lots of little sectors and rearranging them, you can make what looks like a rectangle [as illustrated in figure 1]. And in the limit, using infinitely thin sectors, it *is* a rectangle! I showed this in my *New York Times* piece "Take It to the Limit," and it got a very big reaction. That column made it to the number one most emailed.

It only takes about five minutes, but I've found



Margaret Nelson

Figure 1. Sectors of a circle converge to a πr by r rectangle.

that showing someone that proof almost invariably convinces them that math is beautiful and scintillating. It's just a great argument. There's a moment of revelation: It looks like the proof isn't going anywhere at first because you haven't used enough sectors. But once you draw enough, and it becomes clear this shape is converging to a rectangle, there's a big "Aha!" for most people.

PH: Is it important to spread the idea that math is beautiful?

SS: Yes, but there can be something off-putting about emphasizing the idea that math is beautiful. If you don't get it—if you don't see it yourself—you feel left out.

PH: It's like a clique.

SS: Yeah. It has the empathy problem that I'm always talking about. By emphasizing that math is beautiful, in a way you're not showing enough empathy because you're excluding the people who don't get it. Some people get a lot of satisfaction out of math, although they might not describe it as beautiful.

I think that's where my kids are. They don't see the beauty of math. But they do get the feeling of satisfaction when the numbers work out, or when they get the right answer. I was the same way as a kid. I wasn't aware that math was beautiful; that didn't occur to me. But it was very satisfying when you could get everything to work.

PH: So, math is beautiful; math is satisfying. What else?

SS: Math is real, in the sense that it describes what's happening in nature.

Math is useful, in that it can help you design and build things.

Math is true. There are many parts of life where you can't be sure, but in math you can be sure: You get the pleasure of having truth. It's good for people to be exposed to the idea that there are certainties, even if there are many uncertainties in real life.

Math is valuable, in the sense that it can help you in your career; it can help you get a good job. This isn't an argument I often make, but it's very important to many people. Math provides an opening to some of the most exciting and profitable careers a person can have.

Math is human. There's a great history of struggle and accomplishment. Anyone who likes history or human achievement or culture would like that part of math.

PH: The human stories of math are sadly absent from most math curricula.

SS: And this is closely tied in with math being creative. Math is a place where human inventiveness shines.

PH: Math is collaborative?

SS: Yeah, math is social. We're on to something good with this list we're making, aren't we? The fact that math is social would come as a surprise to the people who think of it as antisocial.

PH: It might also come as a surprise to some math teachers!

SS: It's extremely social. Mathematicians constantly spend time talking to each other about places where they're stuck. They get insights from each other, new ways of looking at things. Sometimes it's just to commiserate. That is the experience of a professional mathematician: being stuck most of the time. For many people it's an unpleasant aspect of doing math. It's very uncomfortable to be stuck.

PH: It's important for students to understand that being stuck is a natural part of doing math, but it can be hard to communicate that to them.

SS: So much of what we do in school is good citizenship exercises. If you follow this procedure, everything will work out. That's not what it's like to do math at the creative level. Being good and following rules is not enough. You have to have a spark or some inspiration.

PH: So what else is on this list? Social. Human. Creative. True. Fun?

SS: Fun! Of course fun should be there. I don't know how to say what is fun about it, but it is fun. It's fun for all the reasons we just listed.

To read more of this interview, see the *Aftermath* column on page 34 and the *Math Horizons* website *maa.org/publications/periodicals/math-horizons/math-horizons-supplements*. ■

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