

The Mathematical Dramatist: Interview with Gioia De Cari

Julie Rehmeyer

Gioia De Cari was a third of the way through her doctoral thesis in math at the Massachusetts Institute of Technology when she up and left. She became an actress and a playwright and hasn't thought about research mathematics again.

What happened? Why would a woman abandon a promising career, a love of mathematics, and years of labor in order to start from scratch in the risky world of art?

Those are the questions De Cari explores in her one-woman play *Truth Values: One Girl's Romp through M.I.T.'s Male Math Maze*. She depicts her experiences in the MIT math department in the late 1980s, showing the thrill and the grind of research, her sense of alienation, the supportiveness and remoteness of her professors, her struggle to connect with her fellow students, the ever-present sexism that ground her down, and how she found her true calling.

Truth Values premiered in August 2009 at the New York International Fringe Festival, winning the 2009 Fringe NYC Overall Excellence Award. It then traveled to Cambridge, MA, in September, where it sold out its entire three-week run. Its three performances in San Francisco during the 2010 Joint Mathematics Meetings sold out as well. It is continuing to play in both public and private performances around the country.

JR: What made you decide to write the play?

GC: In 2000 or so I did a solo show called *The 9th Envelope* that was like an Alice in Wonderland fantasy story, and I wove in some interludes about math. What really surprised me was how captivated audiences were by the math parts. People would come up to me afterward to talk about them. I thought, "Oh wow, my next show better be all about math!"

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That was the genesis of *Truth Values*. But as I got into it, I found there were all kinds of things that were difficult about turning autobiographical material into a work of art. In particular, how do you find the right tone? My perspective was that everyone I had known in the math world was just doing the best they could, even if it wasn't as good as it needed to be. I didn't want to go in a negative direction with it, but the play also couldn't leave out the sexism, because that was a strong aspect of what happened to me. I was fighting with myself about it, thinking, "Look at how far MIT has come. I shouldn't bring this up *now*." In fact, I'd decided to shelve the project.

But then Larry Summers came along. [In 2005, while Summers was president of Harvard, he remarked in a public forum that he believed that differences in inherent aptitude were a bigger factor than sexual discrimination in the low numbers of women in the upper echelons of academia.] When he said that, that's when I thought, I've got to speak up here.

The most upsetting thing to me, even more than Summers's comments, was what happened to Nancy Hopkins in the wake of the comments. She was a biologist at MIT, and she was there when Summers made his remarks. She said afterwards that she left because otherwise she would have blacked out or thrown up. The press just ripped her to shreds over this. She got hate mail for a year.

As an artist, you have more license to say certain things than academics or scientists do. So at that point I felt like I had a responsibility to speak up, and I finished the play.

JR: Before you wrote the play, what did you say when people asked why you left MIT?

GC: At first I tried to keep my math background a secret. Honestly, what does it have to do with being an actor? Then, invariably, someone would want to know where I went to school and I'd have to

tell them and they'd get all interested, and they'd back me in a corner and say, No, no, no you have to tell me!

So, I would tell them some stories about being in math. I was always surprised that people actually found them interesting, and these stories eventually became the show.

Sexism was the thing I *really* didn't want to talk about. When I first thought about creating the show, I thought maybe I could leave it out entirely. But of course I couldn't. It was too important a part of the tapestry of my experiences in that world. When I was at MIT, several professors asked me, "You're married, so why are you here? Why aren't you having babies?" One of my professors asked me to deliver cookies to a seminar. I was driven out of my office by an overly amorous fellow student.

It's such a difficult thing, with sexism, to suss out exactly what's happening. All the time while these things were happening, the question was in my mind, Is this sexism, or is it something else? I'd think, oh, I'm making a mountain out of a molehill. It's just a plate of cookies! It's trivial, isn't it? Why is this bothering me? It's after a zillion little things that are no big deal that it sneaks up on you.

JR: What impact did it have on you to be asked, for example, if you really wouldn't rather stay home and have babies? Why was it a big deal?

GC: I was shocked. I never imagined that anyone would ask me that. I didn't even experience it as sexism. It just upset me and I didn't know why. I didn't understand it at all. It took me so many years and writing this play to understand how I felt about that.

I think the reason it was so hard is that it pressed my buttons. I had come from Berkeley, which was a very liberal and progressive place, but in point of fact, some of my friends and family tended to be pretty socially conservative in many respects, and there tended to be a strong emphasis on having a family. The fact that I was at graduate school, not having a family yet and deciding to put it off, was something that was not in line with a lot of people in my circle and their values. I always felt bad because I always wanted to please everyone in my circle, all my family and all my friends.

So I felt like, well, I can go and do the Ph.D. and I'll make my dad happy and proud, and then I can



Gioia De Cari, left, and above performing in *Truth Values*.

go have a family and make everyone else happy and proud. Everything was about pleasing everyone else. It didn't occur to my young, naïve, immature self that these kinds of questions are also about pleasing yourself. So that question pressed my button and made me feel like, I'm not doing the thing I'm supposed to do.

Of course, it took me many years to think it through and think, Do you think anyone asked men this? Were these guys asking the male students, Gee, you're married, why aren't you having kids? You wonder. Maybe they were, who knows!

JR: Many women respond to these issues by desexualizing themselves: dressing just like the guys, picking up the masculine norms of the place, removing any hint of femininity from their speech or movement or actions. How did you handle it?

GC: In the play I show how I tried to do that and then started having nightmares, because that ran so deeply against the grain for me. The femme side of me is very strong and deeply important to me. When I tried to excise it, I had recurring nightmares that my breasts were chopped off, night after night, to the point where I gave up on hiding my femininity. I decided that it really deeply went against my nature, so I had to go back to dressing and behaving in a way that I felt more comfortable.

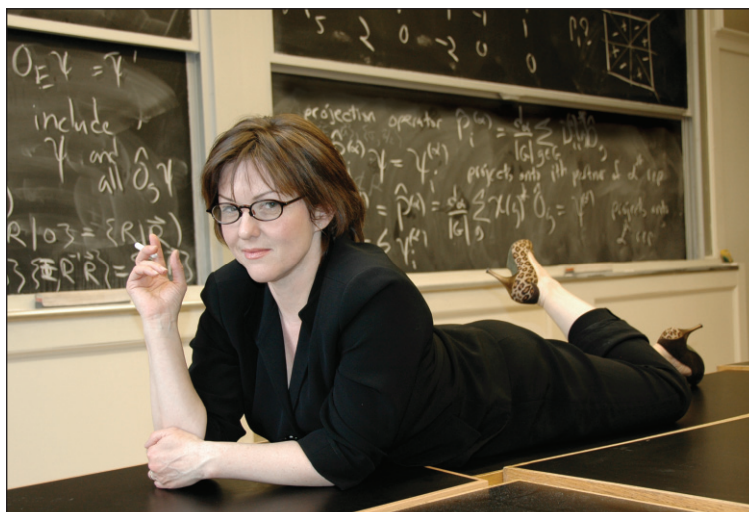
But then, my usual reasonably feminine look started to morph, without me quite intending it. I started acting out by wearing more and more outrageously feminine outfits, to the point where I started calling them "fashion experiments". I just sort of found myself doing it every day. I was guided by some wicked elf on my shoulder. I once found myself wearing something so outrageous that I got myself into quite a predicament.... But I won't spoil that. You'll have to see the play to find out.

Photos: John Olson.

JR: It seems like this illustrates how the gender issues go beyond simple sexism and into issues of style and culture.

GC: Absolutely. Also, I would say, there's an aspect that's not a man-woman thing necessarily. It might be a personality thing. It might be about people who are people-oriented versus data-oriented, concept-oriented.

I wonder if women are more encouraged to be people-oriented, and so it's brought out in them more. Maybe if men are not inclined that way, they're left to their own devices more. I wonder.



Postcard advertisement for *Truth Values*.

I felt for myself the personality issue was a big, big part of it. Humanity interests me far more than mathematics ever could. That's not necessarily the right sort of personality for mathematics.

JR: That's so interesting, and it connects with a moment in the play: As you are getting increasingly unhappy in math, you ask for advice from more senior women in mathematics, and one of them tells you that if you can do anything else other than mathematics, you should. That seems to be a common attitude in math, that you're only a real mathematician if you suck at everything else. By that standard, admitting that humanity interests you more than mathematics is tantamount to admitting that you're not cut out to be a mathematician. But why should it? Why can't you be extremely interested in humanity and also be a very fine mathematician?

GC: Yes, I've had this conversation with other people, too. After performances of my play, a lot of people talk to me about these sorts of things, especially people from other fields in science than math. They've suggested, "Wouldn't science be better off if we had more people in it who did approach it from a humanitarian point of view?" Maybe we would do better science. Maybe it would up the creativity level. If we're only going to select

people who are only really narrow-minded and their focus is really tiny on their work, what does that do to science?

JR: So do you think staying in mathematics could have been a good decision for you?

GC: No, I don't. I'm happy with my decision to leave math. I think it was the right decision. I mean it's crazy to be an artist. That's a crazy decision. But somehow I ended up an artist. I didn't leave math thinking that would happen, I just left math to leave it. Somehow it has worked out well for me, and I've never questioned the decision to leave one bit.

JR: What if the mathematical community had had less sexism? Do you think it could have worked for you?

GC: I would have had to carve out a way of working that suited me that included both math and art. For example, someone who has done that is Tom Lehrer. He carved out a really interesting career for himself that bridges math and art. If I'd have done something along those lines, maybe it would have worked out. Maybe. But I think the standard academic life, or teaching somewhere, I'm not sure I was suited.

JR: During the play, you comment, "There is a kind of exquisite artistry to a mathematical proof. It's a thought sculpture built from the poetry of pattern." That's such an eloquent description of what draws so many mathematicians to math. Does that beauty still appeal to you, even though you don't do math these days?

GC: No. I feel like that description is an artist's description of mathematics. I feel like math is a sculptural medium that I used to work in as an artist that I don't work with anymore, just like someone who once sculpted in marble now works in clay. Now I work in words and emotion and music and lyrics and body shapes and gesture and story. I think of acting as a body sculpture. That's my medium now.

JR: As you were writing, were you worried about how people you knew would react?

GC: I was worried about that, but I dealt with that by creating characters that are collages based on a lot of different elements, not only on math people I knew at the time. As an artist, it doesn't interest me to do portraits anyway. I love to create character collages, that's the way I like to work. Once I allowed myself to go fully in that direction, I wasn't so worried anymore, because there are no portraits of anyone in there.

JR: How has the mathematical community responded so far?

GC: I've had wonderful response to it. It caused quite a stir at MIT. MIT math had a departmental meeting in advance of it playing in Cambridge. Maybe they were a little worried about what I was going to say (laughing). But then a lot of people in the math department came to see it, and some

came more than once. They really were very, very positive about it. The response has been fantastic.

JR: *What impact would you like the play to have, either on people in general or on the mathematical community?*

GC: It does seem to have an impact. It stirs people up, it gets them talking and thinking about issues about women and math and science. That's lovely, and I'm so glad that that's happened and that I can be of service in that way.

But that wasn't my intention exactly. I was acting purely as an artist. I had something to say and I wanted to say it in the most artistically satisfying way possible. I didn't really have an agenda or a moral or something I wanted to impart. I just knew I had to say what I had to say.

When I was initially working on this play, I immersed myself in a whole bunch of the most well-received, greatest, most celebrated solo shows that I could. The thing about solos is that when one person morphs into all these characters, if it's done well, the audience comes away with a sense of

our shared humanity, how we might not be all that different after all. There's something very deeply moving about that.

I hope that people come away from my show with that experience. I also hope that they laugh and have a good time, that they are moved and touched by it, and especially that they might think a little differently about what it's like to be a woman in math and science than when they sat down at the beginning of the show. Sometimes, you have to have a vicarious experience of someone in a certain situation before you really get it. You can talk about it in academic colloquia all day long, but sometimes it's that visceral thing you get from storytelling and theater art that kind of opens your eyes. I think maybe Larry Summers needs that.

Ms. De Cari is bringing *Truth Values* to universities and stages around the country. To discuss booking her show, contact booking@unexpectedtheatre.org.

Book Review

The Calculus of Friendship

Reviewed by Lawrence S. Braden

The Calculus of Friendship: What a Teacher and a Student Learned about Life While Corresponding about Math

Steven Strogatz

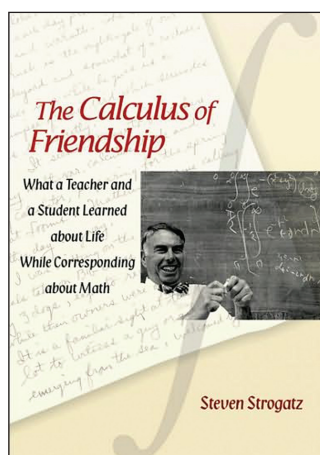
Princeton University Press, 2009

US\$19.95, 192 pages

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Ostensibly, *The Calculus of Friendship* would at first appear to be a simple story of a high school student and his teacher, drawn together by their love of calculus, in which calculus was the bond that cemented their friendship over three decades. It is that, but so much more. Perhaps the book should be titled *A Calculus of Friendship*, using the tertiary definition of *calculus* as a recipe, or formula. But let Strogatz tell it in his own words: "Like calculus itself, this book is an exploration

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of change. It's about the transformation that takes place in a student's heart, as he and his teacher reverse roles, as they age, as they are buffeted by life itself. Through all these changes, they are bound together by a love of calculus. For them it is more than a science. It is a game they love playing together—

so often the basis of friendship between men—a constant while all around them is in flux" (from the Prologue, page xii).

Most readers would assume at first glance that the young math-geek Strogatz would be intellectually drawn to the subject by the older (by thirty years) Mr. Don Joffray, a physically imposing man, "a stronger version of Lee Marvin, whom I'd seen in lots of war movies." (Indeed, Joffray was at one

time the national whitewater kayaking champion). The truth is much more subtle and interesting. In fact Strogatz thought of Joffray as “soft”, not giving his students the red meat of mathematics. While the tenth grader Strogatz was learning the epsilon-delta definition of “continuity” in precalculus from his MIT-trained teacher Mr. Johnson, he found out that Joffray was telling *his* students that “a function is continuous if you can draw it without lifting your pencil from the paper.” (Lest we judge Mr. Joffray too harshly for this, none other than Creighton Buck once told me that in his freshman calculus classes at Wisconsin, he did not make much of an issue of epsilons and deltas either.) Don Joffray always wished that he knew more mathematics (who of us has not?). Thus Strogatz’s delicious morsels were a balm unto his soul and the beginning of a beautiful friendship.

I am exactly fifteen years older than Strogatz and fifteen years younger than Joffray and have taught calculus to bright high school students for thirty-five years in private schools in Hawaii and New England. Philosophically, I am more of a Mr. Johnson than a Mr. Joffray, perhaps to my students’ detriment, perhaps not. Who can say? But we all love calculus and all love sharing the wonderment of such a subject with others.

Joffray was probably learning as much about calculus from Strogatz and some of his other gifted students as they were learning from him. Joffray was the sort of teacher who would pose a problem to the class to which he did not know the answer. He took the greatest delight when one of his students would solve a problem such as this, especially when he was unable to solve it himself. So from the first the two of them were aware that the student was by far the more mathematically powerful of the pair and knew almost as much mathematics as the teacher.

But Joffray, a happy, enthusiastic man, challenged his students to a higher level than many more-traditional teachers. There was simply no telling what the “lesson of the day” would be. One day Joffray walked into the class and told of a goat he saw tethered to a tree that weekend. The goat, wishing to escape, went around and around the tree, keeping the rope taut. What was the equation of the goat’s path? Young Strogatz could learn all the calculus from the book himself. But it was questions such as these that hooked him. Indeed, he says on page 5, “With the passage of time I see now that I was like the goat tethered to the tree—and Mr. Joffray was the tree. I pulled taut on the rope and tried to get away from him, but only ended up wrapping myself closer and closer to him, all these years. How did that happen? It wasn’t because he taught me so much in the usual sense. No, his approach was so humble and unconventional, it confused me. It made me feel superior to him. I’m embarrassed to admit that, but it’s true.”

At the end of Strogatz’s junior year, his school (Loomis) held its annual awards ceremony. Strogatz won the Rensselaer Prize for the top junior in math and science. Joffray made a speech, likening his student to a mountain climber, ascending mathematical peaks and then returning with what he had seen. He made Strogatz feel generous, and even heroic.

The bonding started much more slowly than one might have thought. It was the student (perhaps once every year or so) writing to his old teacher and telling him about interesting problems he had come across in his college studies. One of the first concerned the irrationality of the square root of 2 and the proof that every precalculus high school student is taught—a very neat and clever proof, but one rooted in number theory. At Princeton Strogatz was taught a *geometrical* proof by his teacher, Benedict Gross. It was much more complicated than the standard one, but purely geometrical and very clever. After sharing it with Joffray, he challenged Joffray to use the method to prove that the sides of the Golden Rectangle are also incommensurable.

The chapters of *The Calculus of Friendship* are sewn together with an underpinning of advanced mathematics. As the friendship slowly(!) blossoms, the author uses specific mathematical problems they shared as chapter headings. (Appropriately, the chapter containing the problem about the square root of 2 is entitled “Irrationality”.) Some of the others, for a flavor of the book, are “Shifts”, “The Monk and the Mountain”, “Pursuit”, “Randomness”, “Infinity and Limits”, “Chaos” (of course!), and “Celebration”. Each of these is annotated, in chronological order, with the appropriate years when their relationship went through that phase. For instance, “The Monk and the Mountain” refers to the June 1961 column of *Scientific American* in which Martin Gardner posed the riddle of the monk who starts ascending a mountain at dawn, reaching the summit at dusk. He spends the night and, at dawn, starts down the mountain on the same spiraling path, reaching the bottom sometime before dusk. Every topologist knows that there is a point on the path where the monk must be at the same time each day. Perhaps this is the first “fixed point theorem” a student encounters, beautifully solved by imagining that there are *two* monks on the path the same day...one ascending and one descending. Surely they must meet. Strogatz likens this phase of their relationship (1989–1990) to the monk and the mountain. His own career as a teacher was about to take off at the Massachusetts Institute of Technology, and Joffray’s, at age sixty-one or so, reached its apex and was headed for decline. It was at that time that Strogatz and Loomis classmate Ed Rak, a mathematical genius, were invited to return to Loomis to give a speech at a faculty banquet honoring their old mentor.

Joffray had won the 1990 Swan Award for Teaching, given by a *consortium* of schools “to a teacher whose achievement represents the highest standards of the profession.” It was at this point that their correspondence really took off.

And thus it started, neither party imagining just where this correspondence would lead. Strogatz is not only a first-rate mathematician but a master teacher as well, as anyone who has seen him teach will testify. (I daresay that any person teaching high school mathematics should see his twenty-four lectures on chaos from The Teaching Company on DVD. They are masterpieces of clarity, and any inquisitive person, no matter what his or her background, would probably be enthralled with the subject.) Strogatz is the sort of person who not only enjoys learning his subject but enjoys sharing that learning with others, and who better than Mr. Joffray? The problems that Strogatz shared with Joffray, and his comments and solutions, are truly beautiful ones, most certainly more advanced than one usually is likely to run across in the Advanced Placement Calculus curriculum.

As an example, much emphasis is placed on *convergence* (absolute, conditional, or none) of infinite series in high school calculus. Few of these can actually be summed (ignoring specific ones obtained by “plugging in” to a Maclaurin series.) But what on earth is to be made of the infinite sum of $(\sin j)/j$, summing over the positive integers? Joffray asked Strogatz about this problem, which arose in his class. (Regrettably, the integral test, a standard tool, is invalid here.) What followed was a beautiful nine-page exposition into Fourier series, and the problem was solved. (Okay, if you are curious, it sums to $(\pi-1)/2$.)

Strogatz was so jazzed (his word) by his back-and-forth communications concerning this with his old teacher that he shared it with pal Rennie Mirollo while waiting for their food in a Chinese restaurant. Mirollo, with the help of the place mat, solved it using not Fourier series but Taylor series in the complex plane. A totally different and elegant solution! Joffray was ecstatic (there is no other word for it) upon receiving the second proof. This book is *chock full* of elegant problems, elegant solutions, and the give-and-take between two master teachers.

But something was missing from all of this. After years of corresponding with one another, Strogatz’s wife said “Well, after all this time, you two probably know quite a lot about each other.” Then it hit him...he did not really know his old teacher *at all*, not as a *person*. “You don’t!” she replied. “That is really such a *guy* thing!” Strogatz had, without ever realizing it, relegated Joffray to a category of “friendship” shared with his weekly basketball group—e.g., “how many children they had” was irrelevant. Strogatz came to realize, much to his shame, that it was he who had taken

refuge in the mathematics, shutting the door when Joffray talked about the loss of his twenty-seven-year-old son to cancer, or when Joffray mentioned Strogatz’s impending marriage. Life may be continuous, but it is certainly bound to contain non-differentiable points. On his side, Strogatz never mentioned that his marriage had failed or that his father had died. For a while Joffray’s letters lay unopened on Strogatz’s desk...he had stopped corresponding altogether. He at that stage of his life was emotionally exhausted. He didn’t even respond when Joffray wrote to say that he had suffered a stroke and was partially blind. In April 2004 Strogatz’s brother unexpectedly died. Joffray wrote to say that he had heard the news via the Loomis alumni magazine and sent condolences. It was this that that shook Strogatz out of his lethargy. He phoned his old mentor and said that he wanted to come up and, for the first time, *really* have a down-to-earth talk. With a tape recorder.

The rest is history. And a beautiful book, bound to become a classic in the mathematical literature, in this reviewer’s opinion. Like Hardy’s *A Mathematician’s Apology*, you do not have to know any mathematics whatsoever to read this book. It is a candid and all-too-human story told with brutal honesty...warts and all, sharing with the reader the elation and sincere regrets bound up in the relationship—but in the end, the victories, too. With some beautiful mathematics throughout!

Strogatz’s friend Alan Alda (yes, *that* Alan Alda) conducted a very perspicuous interview with the author. It may be accessed at <http://press.princeton.edu/video/strogatz/alda.html>.

But you would be cheating yourself if you only watched the interview and did not read the book.