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Making Math Pop

By Daniel N. Rockmore

Adam Niklewicz for The Chronicle Review

You never forget your first love. I'm staring at her right now: a well-thumbed copy of E.T. Bell's *Men of Mathematics,* the successor of my first copy, acquired when I was a first-year pre-med, which literally crumbled in my hands a decade ago. In this thick tome, first published in 1937, Bell surveys the world of math up to the early 20th century, with short biographical profiles of math's all-time all-star team. The stories are tinged with a sort of swashbuckler patina, replete with romance, madness, danger, vendettas (even a duel or two), and intellectual breakthroughs, many, of course, "against all odds." It is a feast of beautiful minds, each fit for a Hollywood moment.

Some of the stories blend a bit of fiction with the facts. Bell describes, for instance, Évariste Galois creating group theory in 1832 during a night of feverish candlelit writing in prison awaiting

a duel that would take his life at age 20. In fact, Galois was in prison, but the letter he was writing was a synopsis of work he had accomplished over a long period.

Nonetheless, such tales, however enhanced, convey mathematicians' courage, intelligence, and perseverance while entertainingly presenting their mind-bending concepts, from the paradoxes of the Greek philosopher Zeno (Achilles and the tortoise, for instance) to the German mathematician Georg Cantor's set theory suggesting an "infinity of infinities."

These are tales not just of adventure but of logical leaps and extraordinary geometries. I thrilled to the story of Joseph Fourier, who survived the ebbs and flows of Napoleon's favor while also inventing the eponymous mathematics that underlies periodic motion and is at the heart of modern signal processing. Cantor's personal and professional struggle with the infinite made my mind reel and my heart sink.

I reread these stories again and again, thinking that it might be fun to learn a little more about this mysterious world of mathematics. It turns out that it was. From being a pre-med chemistry major who saw little reason to take a math course beyond first-semester engineering calculus to becoming a math major and eventually a mathematician, I was influenced by many factors. But Bell's spicy biographical tour of mathematics surely played a role.

You might reasonably say that because I was a child of a physics professor and a schoolteacher, the road I traveled was hardly improbable. But even given that, I like to think that my story reflects the important role that books of popular science and mathematics play in science, technology, engineering, and math educations. It is a point that often goes unnoticed, lost in the cries for curricular advances, pedagogical enhancements, research relevance, and the like. As important as it is to instruct well, it is also important to inspire. President Obama has said that this is our "Sputnik moment" in educating the next generation of STEM professionals. But who will be the astronauts for this Sputnik

moment? What stories of scientific and mathematical exploration will inspire the next generation? Where are the Carl Sagans for the 21st century?

I had those questions in mind as I read Steven Strogatz's lively and engaging recent book, *The Joy of X* (Houghton Mifflin Harcourt, 2012), derived in part from his popular 2010 *New York Times* column "The Elements of Math." Part personal and part pedagogy, the book is, as he says in the preface, a collection of 30 "bite sized" morsels intended for "snacking on" by the mathematically curious and receptive but perhaps not the entirely uninitiated, as indicated by the presence of an equation here and there—even a differential equation—as well as a derivation or two, albeit simple ones.

Strogatz carves the world of math into continents—Numbers, Relationships, Shapes, Change, and Data—and moves easily between math for math's sake and applied mathematics. Strogatz himself is an applied mathematician, but one who never lost his love for pure puzzling, whether it be the mysteries inherent in the necessity of 180 degrees in every Euclidean triangle or the ability of conic sections to explain the eerie phenomena of whispering galleries. Those are the kinds of things that attract many kids to math, and these little essays might be read by those kids or by the adult who always regretted that he or she didn't learn a little more mathematics.

Strogatz is a Cornell University professor and an American Academy of Arts and Sciences fellow, and has received teaching awards from the Massachusetts Institute of Technology and Cornell. He takes the point of view that no mathematical idea is too simple to take seriously, and that all mathematical ideas can be sources of interesting stories and concepts. The book begins with the simple act of counting, and ends by touching on the mysteries of infinity. In between, Strogatz samples from calculus (Change) and probability, and explains some basic concepts linked to shape, including topology (the Möbius band) and differential geometry, which adapts the math of Cartesian

coordinates to curved surfaces and spaces.

Those last two concepts are included in a final section called "Frontiers," less because it is about the frontiers of research (although it does include a nice short essay on the Riemann hypothesis, a famous open problem related to patterns in prime numbers) than as a warning that the reader has passed into a mysterious territory of higher abstraction. Some old favorites—or, for some, headaches—like the quadratic formula and the Pythagorean theorem, make appearances, but illuminated with accessible explanations. I especially liked a visual derivation of the area of a circle as the infinite extreme of a sequence of almost-rectangles.

With such "aha!" moments, Strogatz reminds us of the pleasure of a newly won understanding of a once-confusing idea. This must have been at least part of the attraction of another famous popular math book, Lancelot Hogben's *Mathematics for the Million* (1936). Like Bell's, Hogben's book has a place in my memory, but a very different one. It sat on a bookcase at home, a relic from my father's childhood, full of exercises and somewhat ponderous prose. Where *Men of Mathematics* was all flash and mystery, *Mathematics for the Million* struck me plain and simple as work.

That was by design. Bell's intention was to show "what sort of human beings the men were who *created* [Bell's italics] modern mathematics" and to use that to explicate some of the "dominating ideas governing vast tracts" of the field. Hogben, on the other hand, tells us that he wrote his book "in my capacity as a private citizen interested in education," and that his goal was to reach the "million or so intelligent people who have been frightened by mathematics." "The asides and soliloquies," he wrote, "should not be taken too seriously. They are put in to sweeten the pill. Maybe many of them have as little nutritive value as saccharin." Even with that caveat, *Mathematics for the Million* has sold over half a million copies and is still in print.

The few sentences quoted above give a pretty good idea of

Hogben's overall tone. He is the slightly imperious but well-meaning and all-knowing grandfather. Strogatz, on the other hand, is the jolly uncle. He is less Orpheus leading the fearful into the depths of mathematical profundity than a yuk-it-up cheerleader who knows that some of these ideas are complicated. He adopts the tone of friendly math guy, giving examples from his own life as motivation or introduction.

In the course of learning about algebra, we hear about Strogatz's kids. As we make our way into an essay on calculus, we learn that his father repaired B-24 bombers and didn't go to college. The dreaded logarithm arises in a reminiscence about the TV show *Moonlighting*. The personal material gives a conversational feel to the book, which is replete with silly jokes and wordplay. Discussing the root of the word "calculus," a pebble used for counting, Strogatz riffs, "To enjoy working with numbers you don't have to be Einstein (German for 'one stone'), but it might help to have rocks in your head." Some readers will enjoy such tangents more than others, but as someone who has known Strogatz for many years and even interviewed him for two documentary projects, I can vouch for the authenticity of that voice.

By the book's end, the reader is left with the feeling that this is a guy who is thinking about math all the time. Whether he's flipping his mattress (group theory), watching *The Sopranos* (infinite series), negotiating complicated love relationships (dynamical systems), or engaging with family and friends, life is viewed through math goggles. That's instructive, and I think it will resonate with mathematicians everywhere. The mathematical outlook, odd as it may sometimes be, doesn't disappear after the office lights are turned off.

It is in that regard that *The Joy of X* distinguishes itself. For while there are now many excellent popular expository books available that illuminate all kinds of math, and now, too, a new Museum of Mathematics in New York City, there are fewer materials that give insight into how the mathematician's mind works. Edna St.

Vincent Millay famously wrote that "Euclid alone has looked on beauty bare." We can only hope that with a new generation of books like Strogatz's, Euclid soon will have a little more company.

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