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Calculust

A new book that can make you love calculus

By Steve Mirsky

The great Greek scientist, engineer and mathematician Archimedes left us two quotes that ring through the centuries. His study of levers is said to have led him to remark, “Give me a place to stand, and I will move the world.” And the famous *Eureka!* (“I have found it!”) came from his discovery, allegedly while taking a bath, that the volume of an irregularly shaped object could be determined by submerging it and measuring how much water it displaced. Sadly, there’s no evidence that he ever uttered the mash-up “Give me a place to stand, and I will take a shower.” Which seems like an Archimedes screwup.

Archimedes gets lionized (but Androcles is not mentioned) in the new book *Infinite Powers: How Calculus Reveals the Secrets of the Universe*, by Cornell University professor of applied mathematics Steven Strogatz. For anyone who vowed that their calculus textbook would be the last thing they’d ever read on the subject, reconsider: “I’ve written *Infinite Powers* in an attempt to make the greatest ideas and stories of calculus accessible to everyone,” Strogatz notes in the introduction. Then, throughout the book, he gently explains the basics—and gives a historical context that makes for a fascinating read even if you skip the math parts completely. Like you may have done with your textbook.

The history includes the fact that the word “calculus” comes from the Latin root *calx*, meaning a “small stone.” “A reminder of a time long ago,” Strogatz writes, “when people used pebbles for counting and thus for calculations.... Doctors use the same word for gallstones, kidney stones, and bladder stones.” In my younger days, I studied derivatives and integrals, but I don’t recall learning until I read *Infinite Powers* that both of the two 17th-century geniuses usually credited with the invention of calculus, Isaac Newton and Gottfried Wilhelm Leibniz, “in a cruel irony ... died in excruciating pain while suffering from calculi—a bladder stone for Newton, a kidney stone for Leibniz.” At least it was just hyperbole if you ever complained in school that calculus was killing you.

Calculus deals with a lot of curves, and Strogatz thinks of the development of calculus as curvy. No question, Newton and Leibniz gave the field a tremendous acceleration. But the stuff before them was not protocalculus, as it’s often portrayed: “To me,” he writes, “it’s been calculus all along, ever since Archimedes harnessed infinity.”

So how did old Archie yoke that enormous ox without getting gored? He, and his followers after him, used what Strogatz calls the infinity principle:

“To shed light on any continuous shape, object, motion, process, or phenomenon—no matter how wild and complicated it may appear—reimagine it as an infinite series of simpler parts, analyze those, and then add the results back together to make sense of the original whole.”

For Archimedes, employing the principle meant determining a circle’s circumference (its diameter multiplied by pi) by thinking of it as an infinite number of infinitely short straight lines. Start with just six lines, and you get a value for pi of 3. Get to a mere 96 lines, and you know that pi is between $3 + 10/71$ and $3 + 10/70$. Not bad for a back-of-the-parchment appraisal.

What evolved over the millennia became the math that gave us modernity. “Without calculus, we wouldn’t have cell phones, computers, or microwave ovens,” Strogatz writes. “We wouldn’t have radio. Or television. Or ultrasound for expectant mothers, or GPS for lost travelers. We wouldn’t have split the atom, unraveled the human genome, or put astronauts on the moon.”

And thanks to calculus, you can use your microwave oven, a flat plate and some grated cheese to get a shockingly good estimate of the speed of light. That recipe is in chapter 10, “Making Waves.” And after doing the experiment, you can eat the cheese. Which is a good source of calcium, another word that comes from *calx*. Also tracing its origin to *calx* is calk, a handy substance to keep around should you make any world-shaking discoveries in the bathtub. ■

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