Symbolic art. Tauba Auerbach (*left*) and Byron Cook.

MATHEMATICS

A Good Sign

When existing notation for explaining a complex mathematical problem wasn't enough, Byron Cook teamed up with an artist to design his own

Mathematical signs have the power to squeeze hundreds of pages of work into a few neat lines. But as math gets more complex, the symbols can show their limitations. Byron Cook, a senior researcher at Microsoft's research laboratory in Cambridge, U.K., and a professor of computer science at Queen Mary, University of London, learned this recently while solving a 70-year-old puzzle called the halting problem.

Halting is the reason some computer programs occasionally get stuck in endless loops. It plagues PC users with the hourglass icon that never disappears, and Mac users with the rainbow-colored "spinning wheel of death." Scientists have known for decades that there is no universal solution to the glitch. But in 2008, Cook made a breakthrough that could help to prove whether most real-life computer programs would come to an end or hang forever.

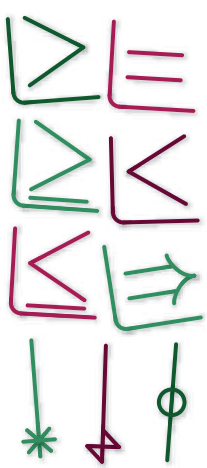
Fellow computer scientists agreed that Cook's approximate solution was important, but the complicated set theory he used wasn't easy to explain. "When I was giving lectures or talking to product developers, I needed to get a lot of information across quickly, and this was getting difficult," says Cook. Things got even tougher when he began to write a book on the subject.

Mathematicians in this kind of pickle often devise shorthand notation to trim down the maze of formulae. "Historically, the abbreviation of complex texts has allowed some problems to be solved that were otherwise intractable," says Patrick Ion, associate editor of *Mathematical Reviews* for the American Mathematical Society. "The introduction many centuries ago of, say, zero, or the equals sign, are thought to be turning points." Roughly 2500 symbols are in use today, most of them variations on earlier symbols or letters of the alphabet.

Cook decided to take a bigger leap. He enlisted the help of a friend, New York City–based artist Tauba Auerbach, a former professional sign writer whose artwork has played with language and technology. For example, her 2005 show "How to Spell the Alphabet" explored the analog and digital ways we express characters, from the optician's eye chart to patterns in binary code. "I often read about math and physics, and they're integral to my art," Auerbach says. "But there was of course a limit to how much of Byron's work I could understand. I brainstormed for days, and my goal was to capture the motion or trajectory of each function—the way the sets of numbers were being grouped or moved in a certain direction."

But when Cook tested the first drafts of the new notation on colleagues, they hated them. Some of the symbols were too ornate to be drawn freehand. One was binned for resembling a swastika; another for being too similar to a Japanese language character.

Through trial and error, Cook and Auerbach learned that new symbols should build on old ones, so they make intuitive sense at first glance. "I knew that Tauba had been successful after I used her final symbols in a lecture and people hardly noticed. Before I knew it, my students were using them, too," says Cook, as he sketches the nine symbols they created onto his whiteboard. The simplest one, representing a mathematical operation that gathers only the right-hand coordinates of a set of pairs of numbers, is a rounded, inverted "L" with an arrow at the end, pointing rightward. In two strokes, it expresses a concept that would otherwise take two lines to explain. Another symbol, which constructs a new numerical relationship for a set of variables using a mapping, is an L-shape with a "greater-than" symbol inside it.



Sensible addition. These new math symbols are designed to be understood intuitively.

"I rather like their notations," says David Bressoud, president of the Mathematical Association of America and a professor of mathematics at Macalester College in St. Paul, Minnesota. "It will be interesting to see if they get picked up beyond the computer science community." That is likely to depend more on the value of Cook's research than on the beauty of the designs, Bressoud adds.

Still, says Ion, "good notation has a tendency to beat out bad notation." Leonhard Euler's decision to use the letter "e" for the base of the natural logarithm around 250 years ago, for example, was so successful that we still use it today. The battle continues, however, between Newton's choice to use a dot over "x" to represent a derivative, and Leibniz's "dx/dt" notation for the same thing.

Although the verdict from his colleagues is still out, Cook says the new notation has made a "dramatic" difference to his own work. He estimates that more than 100 of his students and colleagues already recognize the symbols. Next, he hopes to have them implemented in LaTeX, the typesetting package that mathematicians commonly use to publish their work electronically. After that, Cook says, "our plan is to see what else needs simplification. We might invent some more."

Ion predicts that mathematical symbols are due for a bigger shakeup: "The way we think about notation is evolving. Color may come in, and as technology advances, maybe even animation." **–ANGELA SAINI**

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