UC SANTA BARBARA

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'A Golden Age of Mathematics'

The son of a math prodigy-turned-screenwriter, Michael Freedman's very upbringing is emblematic of how most mathematicians see themselves: equal parts artistic and academic.

When it came to his own career, Freedman — raised with an appreciation of both pursuits and a keen understanding of their connection — chose math. But still today the Fields Medal winner (math's equivalent of a Nobel Prize) believes that his vocation requires "a level of artistic judgment at least equal to the technical power that is needed."

Recently named to the mathematics faculty at UC Santa Barbara, Freedman also serves as director of the campus-based Station Q — a Microsoft research outpost devoted to quantum computing. And he's among a chorus of voices singing the creative praises of a discipline not widely seen as such.

"If you talk to a random person, say on an airplane, you'll find most people think that math is completely worked out — and completely tedious," said Freedman, who in his career so far has also won a National Medal of Science and a MacArthur Fellowship. "I had the advantage of having a father who was sophisticated about mathematics and loved it, who taught me that math is a fascinating, changing subject full of unsolved problems and challenges. I knew from an early age that there was a whole lot to math.

(Michael Freedman discusses his family history and the evolution of his career in math — including his 1986 Fields Medal win — in this recent "Science Lives" video interview with the Simons Foundation.)

“Take this fellow Claude E. Shannon, who invented information theory almost singlehandedly in the 1940s,” Freedman added. “The calculus that was employed was not beyond what thousands of people could have done, but the artistic judgment that there was even a subject there to be created — I think that’s really what his contribution was.

That math is akin to art may be surprising, even counterintuitive, to some. But their innate creativity, mathematicians say — their “artistic judgment,” in Freedman’s words — is helping to advance the field by pushing the limits of possibility, enabling practical applications with implications for human health, technology and more.

There are examples aplenty at UC Santa Barbara, which was rated the best school in the country for mathematics majors in the 2013-14 PayScale College Salary Report and, in the most recent National Research Council rankings, topped all the other UCs in student outcomes including job placement. UCSB also recently ranked sixth in the country for advancing women in the STEM disciplines, whose “M” stands for math.

The campus’s robust math department is as strong in pure, or core, math as it is in applied math. Think of the former as math for math’s sake — a scholarly embrace of abstract concepts — with little more motive than to explore the beauty of mathematical structures. The latter is even more literal: the application of mathematical theories to so-called “real world” problems, from cryptography and actuarial sciences to quantitative biology and quantum computing.

“On the pure math side, some of it is things we just do simply because they’re pretty, though it might turn out later that they’re useful,” said Jeff Stopple, a professor of mathematics whose research focus is in number theory. “But core mathematics is what the new applications are built from. A lot of stuff with commercial applications — cryptography for banking, for instance — comes out of number theory.”

Such is only one piece of the ever-mounting evidence that the lines between these two camps of math are blurring, especially as the mathematical classification once thought to reside only in the purview of pure math is increasingly used on the applied side.

Prime example: Station Q, where Freedman and his team of mathematicians and physicists are working on the fundamental science that will one day be used to build a quantum computer — a holy grail for science and technology. To do so they're employing topology, an area of math traditionally considered to be "pure" but now proving valuable — even essential — to the quantum efforts conventionally seen primarily as the realm of physicists.

"Pure math is classifying mathematical structures, and at Station Q I am classifying quantum states of matter," said Station Q's Zhenghan Wang, who is also a UCSB math professor and a former doctoral student of Freedman's at UC San Diego. "It's very surprising. And this is an important moment for me. What I am doing — purely math — has a connection to the world. And there's one more twist: These new states of matter that I'm classifying may ultimately lead to a quantum computer. That's what a lot of people are interested in — hardware for futuristic quantum computers — and that's the potential for physical application."

Similar co-mingling of core and applied math is happening across campus in research efforts in everything from biology and economics to media arts and the natural sciences.

As beautiful as it is brainy

Have you heard the one about topologists? They can't tell their doughnuts from their coffee cups. (Cue the laugh track.)

So goes a classic barb among mathematicians — a jab at those devoted to the study of shapes and spaces, in whose world a coffee cup and a doughnut have the same properties. The joke elicits appreciative chuckles from math lovers, but among the population at large … probably not so much.

And so it goes with math. Its practitioners and champions consider the pursuit to be as beautiful as it is brainy. To a broad swath of society, however, math is just number crunching and a collection of classes you have to pass.

But in fact, nothing could be further from the truth, according to UCSB's Jon McCammond, a professor of math whose research interest in geometric group theory — in structural symmetries, specifically — proves his point.

“There was a chemist in the 1920s who witnessed the effects of symmetries on the chemical properties of molecules and won a Nobel Prize after applying existing math in the area to his own work,” McCammond said. “And that kind of thing happens again and again. Mathematicians on the pure side are just trying to explore the world of pure structure and to figure out everything that we can. When you come upon an actual ‘real world’ problem, oftentimes mathematicians have stuff you can draw on and use.

“The amount of math being produced right now especially is just unbelievable — it’s just exploding,” he added. “It’s really a golden age of mathematics.”

About UC Santa Barbara

The University of California, Santa Barbara is a leading research institution that also provides a comprehensive liberal arts learning experience. Our academic community of faculty, students, and staff is characterized by a culture of interdisciplinary collaboration that is responsive to the needs of our multicultural and global society. All of this takes place within a living and learning environment like no other, as we draw inspiration from the beauty and resources of our extraordinary location at the edge of the Pacific Ocean.