10

POPSCI'S 2ND ANNUAL BRILLIANT

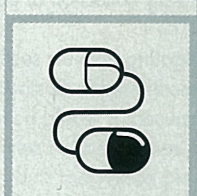
**We patrolled the halls of academe.
We eavesdropped on the research grapevine.
We asked scientists:
Whose work is just plain brilliant?**

GEOPHYSICS [1]

QUANTUM CRYPTOGRAPHY [2]

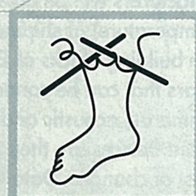
COMPUTATIONAL ORIGAMI [3]

GENOMICS [4]

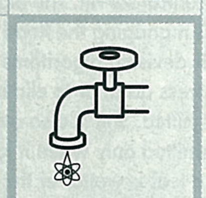


EMBEDDED NETWORKS [5]

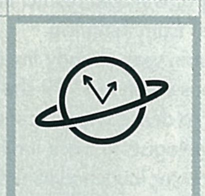
TISSUE ENGINEERING [6]



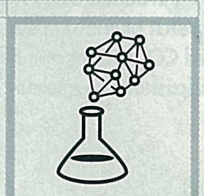
MICROFLUIDICS [7]



COSMOLOGY [8]



MOLECULAR MEDICINE [9]



MOLECULAR ANTHROPOLOGY [10]

ICONS BY CHRISTOPH NIEMANN

NEXT TIME YOU SIT WITH A STRANGER at a dinner party, pray for someone as interesting as any of the scientists in the ranks of the second annual PopSci Brilliant 10. Someone who is well into an exciting career but still picking up speed. Someone in the grip of an obsessive inquiry into the nature of the world—brainy, resourceful, gutsy—and not afraid to talk about it. This year, we again sought researchers whose work, while watched and admired (and certainly envied) by colleagues, is largely unknown to a public that admits few scientists into the spotlight of fame.

One in this year's group traveled East Africa cajoling people for blood samples, then processed the blood in a centrifuge she had jury-rigged to her Land Rover's battery. Another vowed in junior high to defeat the disease that killed a friend—and may very well keep that promise. Many of the Brilliant 10 work in hybrid fields, because as the divisions between disciplines fade, that's where the action is. They meld biology with engineering, computer science with ecology. Some work in fields so new—molecular anthropology, microfluidics—you've probably never heard of them.

This group is but a tiny cohort of the larger community of researchers doing the work that will reveal—and, by revealing, change—our world.

[BRILLIANT 10]

01 02 03 04 05
06 07 08 09 10

TEJAL DESAI

PANCREAS, BLOOD VESSELS OR OTHER ORGAN ON THE FRITZ? SHE'LL BUILD YOU A NIFTY REPLACEMENT.

TISSUE ENGINEERING
BOSTON UNIVERSITY

When Tejal Desai walked into professor Mauro Ferrari's office at the University of California, Berkeley, she looked so young he mistook her for an overeager high schooler and almost threw her out. Undeterred, Desai told him she'd studied biomedical engineering as an undergrad at Brown and was seeking a challenging Ph.D. project. Ferrari assigned her a whopper: Build an implantable device that will eliminate the daily insulin injections diabetics give themselves to control blood sugar levels. Desai's colleagues warned her the task was too hard, that she'd never graduate.

But after four years of coaxing cells to grow on chemically modified silicon surfaces, Desai had it: a microscopic device that, when implanted in diabetic rats, delivered ongoing, regular doses of insulin. The device functioned like a tiny tea strainer: A hollow bit of silicon perforated with tiny holes, it was filled with pancreas cells doing what pancreas cells do naturally—produce insulin. The holes were large enough for the insulin to diffuse out, but small enough that the pancreas cells stayed inside, and the rat's immune agents—which would normally mark the cells as foreign and attack them—could not enter. "Nobody expects you to cure diabetes before you graduate," recalls Ferrari. "And then Tejal did!" (For rats, anyway.)

Desai's implant is being developed by a private company for human use, but Desai, now 31, has moved on. She has developed a speck-size layered plastic device that, when swallowed, attaches to the intestinal lining, releasing medicine. Next she plans to build better artificial blood vessels. The existing variety, mere tubes, cannot constrict or dilate as natural vessels do to control blood pressure. Desai's goal is to make artificial vessels that coax the patient's own body to grow replacements, then biodegrade, leaving the new natural vessels behind.

Desai's father, a chemical engineer whose company designs water-desalination systems, cautioned her about engineering; it can be an unexciting profession, he told her. Then, in high school, Desai heard a biomedical engineer speak. Here was a totally new incarnation of engineering, one packed with magical promise—building artificial organs, or artificial nerves for people with spinal cord injuries. Desai had found her calling. (Her father has since relented; they occasionally talk shop, especially on the topic of nanoporous membranes.) Says Kenneth Lutchen, chair of biomedical engineering at BU, "In 10 years, some promising young student will be labeled 'the next Tejal Desai.'" —MARTHA HARBISON

ERIK DEMAINE

PAPER FOLDING AS EXTREME MIND-SPORT: PUSHING THEORETICAL LIMITS FOR THE FUN OF IT.

COMPUTATIONAL ORIGAMI
MIT

Erik Demaine was not your typical teenager. He went to college at 12, and by 14, he was a grad student at the University of Waterloo in Ontario, Canada. The work he did there sounds whimsical—making paper stars, angelfish and swans—but Demaine was confronting a thorny problem. Namely, which shapes can be made simply by folding a piece of paper, as many times as you like, then snipping off a corner and unfolding it. The answer, Demaine discovered, after two years of calculations and crumpled paper, is *any shape you can think of*. It is theoretically possible to create any two-dimensional straight-sided shape, from a triangle to the New York City skyline, with a single scissors cut.

That elegant theorem, completed in 1998, helped launch computational origami, a hybrid discipline—part computer science, part mathematics—that explores complex geometry concepts inspired by the Japanese art of paper folding. Demaine and a handful of colleagues pursue the mathematics of folding with the bravado of skateboarders. It is their extreme sport; they delight in the mysteries hidden within a simple sheet of paper. "Erik found a whole new pool of mathematical problems motivated by the field of origami," says mathematician Joseph Mitchell of SUNY Stony Brook in New York. "These are the kinds of questions that turn us on." Two years ago, at the ripe old age of 20, Demaine became an assistant professor at MIT.

The work has real-world value. Computational origami has helped engineers figure out how to unfold a telescope lens in outer space without damaging it, and determine the safest way to stow an airbag within a steering column. A grasp of the intricacies of folding could also help biologists understand proteins, the convoluted molecules that are prime actors in many diseases.

Home-schooled by his father, Demaine never had to distinguish between work and play. During his early years, the two traveled the U.S. by bus, stopping to live wherever they felt like it (Demaine's parents divorced when he was young). When Erik was 7 and obsessed with Nintendo, his dad suggested he learn to create his own games; he was soon into computer programming. In college, he found the age gap little hindrance—when his friends repaired to a bar, he just ordered ginger ale.

Demaine keeps countless origami problems percolating in his head, but his research ranges far beyond: He has co-authored more than 100 papers on such topics as data structures, bioinformatics and the mathematical obstacles to winning at Tetris. He's drawn to the unexpected: "You just look at something you normally see in a different way and think, Gee, I wonder if there's some mathematics behind that?" —LAURIE GOLDMAN

COURTESY BOSTON UNIVERSITY

PARTY PUSHER: ERIK DEMAINE MULLS THE MATH OF FOLDED FORMS. PHOTOGRAPH BY ANTONIN KRATOCHVIL

Try your hand at folding problems: www.popsci.com/exclusive