The alchemy of absurdity

Jessica Fridrich transmutes nonsensical questions into dazzling discoveries

Many researchers have spent their careers asking different iterations of the question "Why?" Jessica Fridrich established a place for herself and remains in the vanguard of her field by asking the more audacious question "Why not?"

Fridrich is known the world over for developing brilliant new approaches to problems involving information hiding in digital imagery. Her areas of expertise include digital image authentication, tamper detection, robust watermarking, steganalysis and steganography. Colleagues characterize her work as relentless in its originality and spectacular in its fecundity.

Her 12-year tenure at Binghamton University, where she is a professor in the Thomas J. Watson School of Engineering and Applied Science, includes an unbroken string of externally sponsored research projects that have given rise to five U.S. and international patents, as well as two pending patent applications. Law enforcement agencies, movie makers and government officials all want to know what she's doing next because her work has such important implications in the fights against terrorism, child pornography, counterfeiting and digital piracy.

"A lot of big discoveries come out of trying to do the impossible," Fridrich said. "So in my research group, we often start by asking stupid, silly questions. We look at what is thought to be impossible and say, 'Can we do this?' Anyone who listened to us would say, 'These guys are nuts. Of course you can't do this. What a silly question.'"

Time and again, however, Fridrich has demonstrated that entertaining seemingly ridiculous questions, while daring to ask "why not," just might be the smartest thing a researcher can do. That's what happened seven years ago, she recalls, when during a presentation on steganography — the art of hiding information — she was asked if she could hide something in a digital image without altering the original image.

Her first thought, she now admits, was "That's nonsense." But rather than stopping there, she began to devise permutations that would allow her to do what seemed impossible at first blush.

On the occasion in question, the result of her willful disregard for the presumed bounds of possibility was the development of a ground-breaking, erasable watermarking technique for digital images. Also known as lossless watermarking, the technology is now the subject of a large body of scholarly papers by others in her field. In lay terms, it involves embedding a watermark in the image so that the watermark can be later erased from the image to obtain the original, unwatermarked image. Like magic, Fridrich's technique provides an image that has been changed, but which also remains the same.

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Fridrich says her seemingly contrary approach to challenging the bounds of possibility can be traced back to childhood. Growing up in Czechoslovakia, a precocious toddler’s fascination with and curiosity about the natural world took wing.

“When I was a little child, I liked nature very much,” she said. “I was interested in butterflies and birds, so I would be reading about them, getting binoculars and going out to watch and study them, to be able to identify them in the guide books.”

By sixth grade, Fridrich’s interest moved beyond the treetops and settled on the stars.

“I was learning constellations, what they were and how things worked. I wanted to see more. I wanted to build a telescope, and my father helped me to build one.”

During that star-crossed process, Fridrich discovered a different sort of constellation that would change the course of her life.

“I found some formulas where if you just plug in the diameter of the lens and some other parameters, it will tell you what you will be able to see with your telescope. There was this mysterious function called a logarithm in there. I was only in sixth grade and had no idea what a logarithm was, so I asked my math teacher.

“When she explained, I was fascinated to learn that there are things like this that can magically give you answers to something you don’t know … that even before testing it out, this formula could tell you what the telescope could do for you. In this process, I discovered math and how powerful it is,” Fridrich recalled.

Because Czechoslovakia was “just a little country,” and because “there would sometimes be no openings for astronomers for years at a time,” Fridrich took her concerned father’s advice, which was to retain astronomy as a hobby, but to contrive a course of study that could better ensure a job, not to mention a career.

“I picked the school that everyone said was the hardest to do,” Fridrich said, “the Czech Technical University, School of Nuclear Science and Physical Technology, pursuing studies in applied mathematics.”

“They gave me a good background in physics and math, and I found I just like to crack things, to look at puzzles that seem impossible and find a way to crack them.”

In fact, Fridrich’s name is probably better known for her success in puzzle solving than for her academic research. In the early 1980s, soon after the Rubik’s Cube was introduced, it seized Fridrich’s attention even before it became a global craze.

“There was a silent challenge in the cube,” she said. “There was no system developed for solving it when it first came out. There was a silent challenge to design a system to solve it fast.”

So while most people were turning the cube over for hours, days and weeks at a time, gaining ground on one side only to lose on the others, Fridrich was developing a technique to accomplish the daunting task in seconds. Using the technique that is now known the world over as the Fridrich Method, Fridrich won the first Czechoslovakian speedcubing championship in 1982, and went on 21 years later to finish second in the 2003 Rubik’s Cube World Championship.

“When I was at my best, I routinely solved the cube in an average time of 17 seconds,” she said. “At that time, I was actively using more than 100 algorithms, but the minimum is 53 algorithms.”

The Fridrich Method remains one of the most-used speedcubing methods in the world. Last year, 18-year-old Ryan Patricio credited the technique with helping him win the 2007 U.S. Open Rubik’s Cube Championship in Chicago. He completed the puzzle in a mind-boggling 14.17 seconds.

Fridrich’s willful disregard for the accepted limits of possibility is embraced by her entire research group. Among others, the group includes Fridrich’s co-inventers Miroslav Goljan and Jan Lukas and post-doctoral assistant Mo Chen. Most recently, they developed and continue to refine the only technology that can match still digital images and digital video to the specific device that recorded them. Two patents on the technology are in the works.

“We are also extending the technology so we can identify the camera from images that were cropped and scaled at the same time,” Fridrich said. “You hit the limits of the technology faster

Jessica Fridrich

because you have to do the search for the scaling and cropping, but you can still do a lot."

The technology is now five to six times faster than it was in 2006, when word of its invention for use on still digital images attracted the interest of law-enforcement agencies the world over. In much the same way that telltale scratches allow forensics experts to match bullets to the gun that fired them, Fridrich's digital fingerprinting technique can reliably link still and video digital images to the camera that shot them.

That's because every digital imaging device ends up with distinctive marks on its sensors during manufacture, and Fridrich and her group have figured out how to detect and analyze the pixilated fingerprint left by each device on the images it records. Child pornographers, counterfeiters and movie pirates should be forewarned. The technology promises to put many more of them behind bars in the future than has been possible in the past.

Fridrich's research team has even found a way to use the technology to find fingerprints in printed images, a development that grew out of another visit with apparent absurdity.

"We were being filmed by a Swedish television crew, and the reporter asked, 'So if you print out an image, can you get a fingerprint on it?' We said 'No, that would introduce too much distortion, with the printing and scanning process and the signature will not survive this.' But we looked at each other and chuckled, like, '… what a silly question.'"

A week later, although the television crew was back in Sweden, that "silly" question was still knocking around in Fridrich's head. So she went back to her team and asked, "If we can survive rescaling by 50 percent and jpeg compression, why *can't* we survive printing and scanning?" In short order, the once absurd question became the vital seed from which sprang the group's latest conference presentation, "Identifying Cameras from Printed Images."

"It actually does work. It is easier to detect the signature in prints made at pharmacies or grocery stores than those you print in the lab or at home because the printing quality is much better in photo labs. We can identify the camera from regular postcard-size prints," Fridrich said. "We were very surprised. It's amazing. I would not have expected it in my wildest dreams. It's not a big discovery, but people will be amazed. And we would not have come up with this on our own because we just presumed it impossible."

The key, Fridrich said, is not to dismiss those stupid questions if you get them in your head. "You must nurture them and think about them," she said. "You must have the time to sit around and brainstorm and wonder."

Fridrich is fond of quoting Pablo Picasso, who once noted that "computers are useless because they only give us answers."

"I think this is a great citation, and though he said that quite awhile ago when computers were not what they are today, it is still true," she said.

Maybe in another 50 or 100 years artificial intelligence will change all that, and computers will start devising possibility-expanding questions of their own. But for now, Fridrich thinks, it's well worth our time and effort to strive to recognize and reap the true value of ill-informed questions. They might just offer us the potential to free ourselves from the self-imposed limitations of unexamined misbelief. ■

— Susan E. Barker