■ ANDREW VAZSONYI, Feature Editor, McLaren School of Business, University of San Francisco

Personal Knowledge

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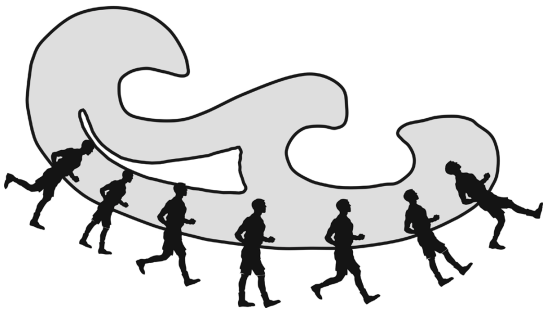


How do we know what we know? Writers, actors, and artists have the ability of entering another person's skin and seeing the world through his/her eyes. Charles Dickens once said, "I *was* Ebenezer Scrooge, when I wrote 'Christmas Carol.'"

Scientists understand the world in such a way through internalized knowledge. They become, in the words of Einstein, "a little piece of nature." My compatriot, Michael Polanyi, the Hungarian-born physicist turned philosopher, examined how understanding comes to scientists, and in fact to all of us, from internalizing knowledge (see his 1958 book, *Personal Knowledge: Towards a Post-Critical Philosophy*).

Richard P. Feynman describes an intuitive empathy toward calculus in his biographical book "*Surely you must be Joking, Mr. Feynman!*"

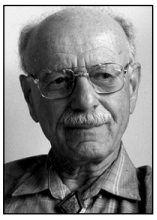
> I often liked to play tricks on people when I was at MIT. One time, in mechanical drawing class, some joker picked up a French curve (a piece of plastic for drawing smooth curves—a curly, funny-looking thing) and said, "I wonder if the curves on this thing have some special formula?"
>
> I thought for a moment and said, "Sure they do. The curves are very special curves. Lemme show ya," and I picked up my French curve and began to turn it slowly. "The French curve is made so that at the lowest point on each curve, no matter how you turn it, the tangent is horizontal.
>
> All the guys in the class were holding their French curve up at different angles, holding their pencil up to it at the lowest point and laying it along, and discovering that, sure enough, the tangent is horizontal. They were all excited by this "discovery" even though they had already gone through a certain amount of calculus and had already "learned" that the derivative (tangent) of the minimum (lowest point) of any curve is zero (horizontal). They didn't put two and two together. They didn't even know that they 'knew.'
>
> I don't know what's the matter with people who don't learn by understanding: they learn by some other way—by rote, or something. Their knowledge is so fragile.

Feynman's anecdote is similar to a problem that was sometimes given to second-year physics students. A person twirls a stone attached to a string. Suddenly the string is cut. What would the stone do? Many students believed that the stone would continue flying in a circle.

But the way to understand the problem is by asking yourself, "If I were the stone, what would I do?" (Einstein, who talked about *visual* and *muscular feelings* when thinking about physics, once asked a similar question, "What would I do if I were a photon?") As long I am the stone tied to the string, I cannot escape. But once the string is cut, I am free from all constraints. Thus, according to Newton's first law, I will continue on a straight line with the same velocity. (David knew this well when he slung the stone that brought down the Philistine Goliath.)

What about the French curve and calculus? I imagine that I am the point running along the curve. I start descending, and end up ascending. Somewhere along the bottom of the valley I will run horizontally. Why? Calculus tells me so.

On my desk is a roulette wheel. When I spin it, I receive a visual and muscular feeling about randomness. I do not see "random numbers," because numbers cannot be random. Sequences of numbers are only samples, finite outputs of random processes. ■



Andrew Vazsonyi
is an internationally recognized author, researcher and educator. He is the author of over 70 technical articles, and seven textbooks, in English, German, Spanish, French, Russian, Japanese and Hungarian. Dr. Vazsonyi received a Ph.D. from the University of Budapest. He is currently an emeritus professor at San Francisco University and has 20 years of teaching experience. Prior to becoming an educator, he served for 25 years in industrial positions. These days he focuses on books and articles that apply Microsoft Excel and VBA to production and operations management.

Dr. Andrew Vazsonyi
156 Oak Island Dr.
Santa Rosa, CA 95409
(707) 539-0272
fax: (707) 537-1833
compuserve: 102113,1352
avazsonyi@compuserve.com