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OBITUARY

Richard G. (Dick) Shoup, 1943–2015

Richard (Dick) Shoup was as multi-talented as he was multi-faceted. He loved playing trombone with his jazz group, Daddios, and will be remembered by his signature piece, *Don't worry 'bout me*. If there ever was an encompassing statement about Dick as a warm, loving man with a dry sense of humor, that would be it.

Dick was farsighted, looking for potential radical breakthroughs often long before others considered them. His Ph.D. topic is a great example. At the time of his Ph.D. (1970), nearly all computers used the von Neumann stored program model with serial execution of instructions and a common memory for data and software. The advantage of this structure is its generality: Any problem can be solved within the framework merely by changing the instructions or software with no change to the hardware. But what if the hardware itself could be adapted for each problem? Dick explored this problem and helped develop FPGAs (Field Programmable Gate Arrays). FPGAs are now widely used in computers and consumer electronics. Dick was also an early developer of computer imaging software. He developed the SuperPaint program, the first successful computer graphics system. SuperPaint was also the origin of today's ubiquitous use of CGI (computer-generated imagery) animation in television and movies. He was recognized by the Association for Computing Machinery for winning an Emmy, an Academy Award, and a Computer Graphics Achievement Award.

Working with Tom Etter, Dick developed a modified version of quantum mechanics (QM) called link theory. After Etter's death in 2013, Dick went on to develop these ideas further. A little background will help understand what he proposed.

The known laws of physics are nearly all invariant under time reversal, the exception being the standard version of QM. Although there are many interpretations of the meaning of QM, the underlying mathematics is well-established and agreed upon and constitutes a theory that has been experimentally tested to extreme accuracy in numerous experiments. This mathematics splits naturally into two parts: the evolution in time of a quantity known as the wave function, and its so-called "collapse" when a measurement is made. The changes in the wave function with time are described by the Schrödinger equation, a second-order differential equation that is time-symmetric, like all of the other equations in fundamental physics (the field equations of general relativity for instance).

It is worth noting that, just as in other physical laws that are described by differential equations, one needs to integrate the differential equation to make forecasts, and this process requires that one inputs numerical constants, known as boundary conditions, into the calculation. For example, the equations that describe the path of a ball thrown across a field also are differential equations, and in order to calculate the path of a particular ball one needs to know the boundary conditions, in this case the initial position and velocity of the ball when thrown. Note that in making forecasts of where the ball is at any instant, these boundary conditions refer to the past. This brief discussion of differential equations and the necessity for boundary conditions, usually in the past, in order to arrive at testable forecasts, is crucial to understanding Dick's ideas.

The second part of standard QM, the collapse, references the Born Rule by means of which the probabilities of the possible measurements are calculated. This process is not time-symmetric and also introduces an apparently inevitable randomness into our measurements. The randomness is integral to the theory because the Born Rule only gives the probabilities of the experimental outcomes, not the individual outcome of any particular experiment. Einstein's strong dislike of this latter process gave rise to his famous remark that "God does not play dice." Shoup and Etter sought to remove the collapse process from QM and thus recover a fully time-symmetric version of the theory in line with the other fundamental equations of physics. To accomplish this, they considered that quantum processes were constrained by boundary conditions in both the past and the future.

The incorporation of future boundary conditions, or constraints, entails that the future state of affairs must influence current measurements, at least in some situations. Clearly in the macroscopic world that we inhabit we observe forward causality everywhere, but we are hard-pressed to come up with observations that require backward causation, or retrocausality, for their explanation. But Dick argued that there are observed macroscopic events requiring future boundary conditions to be included in any tenable theory of them and that these events are the subject of parapsychology.

Since in Dick's theoretical framework the Born Rule is eliminated, the apparent randomness of QM-controlled events is also removed. How then does his account explain the apparent randomness of phenomena such as radioactive decay or photons passing through a beam splitter? Dick argued that the boundary conditions on these processes are in both their past and future. To put it another way, the outcome of a particular apparently random event is constrained by both past and future states of the world. In particular, the future constraints are unknown, and this lack of knowledge is responsible for the observed random behavior. Therefore, Dick viewed the apparent randomness of the micro-scale events as being due to insufficient knowledge rather than being an intrinsic feature of reality, which is the standard QM view.

Dick noted that precognition—a psychic ability to access non-inferentially future events—experiments involved correlations between two states of the world, the subject's information and the randomly chosen stimulus or target in the subject's future. He observed that both these processes involve apparent randomness, in the case of the stimulus selection by design, and in the case of the subject by possible QM-based processes in the subject's brain. Therefore, in his version of QM, both the subject's information and the randomly chosen target are constrained by past and future states of the world. Thus precognition becomes neither seeing the future nor causing it through psychokinesis, but rather a time-symmetric interlocking between past and future events. Thus we see that there are three classes of models of precognition: as for-seeing, as for-controlling, and as Dicks's time-symmetric constraint.

An important question is whether precognition is merely a correlation between subject information and target or whether it can be used for signaling, for sending a freely chosen message from future to past. All three models have something to say on this.

The for-seeing model implies that a future event can retro-cause a current mental state (for instance of a subject in a precognition experiment). It implies that the choice of the future stimulus/target affects the subject's current mentations. Therefore, by manipulating the future stimulus/target to encode a message, we could detect what that manipulation was before it occurs. Therefore, signaling backwards in time is a consequence of this model. In fact, parapsychologists have developed a theory, the Observational Theory, which makes this explicit. This idea has been developed into a protocol called associative remote viewing (ARV), which promises to provide future information with high confidence levels. As one might expect, attempts have been made to apply ARV to practical problems such as forecasting the stock market. Results have been mixed, but it is clear no one has (publicly) announced that they have become wealthy through this methodology.

The for-causing, or PK, model of precognition eliminates retro-causation, and hence backwards-in-time signaling. But it seems to imply that practical applications like ARV should be possible since apparently a precognized event is actually predetermined and thus one could act on that knowledge of a certain, or at least probabilistically constrained, future event, such as a stock market move.

Dicks's ideas on the problem of signaling to the past are complex. He argues:

> If the message (a biased quantum measurement) had been in fact received in the past, it would not have remained open, and so there would be no freedom in the future to send it. Such a quantum message can be sent into the past, but only if it hasn't been read there, since this would destroy the message.

But QM does allow for correlations between current measurements and future states, and Dick writes:

> But correlation can give the appearance of information transfer, and even precognition, in cases where two supposedly random sources are being compared and the result is biased by constraints placed by the future on that outcome.

And when considering parapsychological precognition experiments, Dick goes on to say:

> Whenever a quantum-random source is involved, as it is in most parapsychology experiments (e.g., an RNG target generator that uses a quantum process to produce classical bits), the present theory posits that future conditions determine in part the generator's classical 'output,' and the target for that experimental trial. Thus there is an opportunity—in fact, a requirement—for backwards influence from the trial results and all that is connected to them. In practice, this evidently includes the experimenter (via his interactions with the data) as well as other dependencies.

Thus, Dick's theoretical framework provides a possible explanation for the experimenter and analyzer effects that have been posited for parapsychological experiments as well as suggesting that trial-level feedback to the subject is an important component for success. His model may well be developed in the future into a fully quantified and testable theory of these anomalous phenomena.

A short piece such as this cannot begin to capture such a diverse and talented man as Dick. His accomplishments will be with us all for a long time to come.

Travel well, Dick.

James Spottiswoode