

A NEW Metaphor for Leadership in the 21st Century

by George F. Huhn

laughed as a friend of mine told me that her six-year-old daughter had asked why moving electronic text from one place to another on a computer screen was called "cutting and pasting." Her daughter's question was another example of how we apply old cognitive models of technology and terminology to relate to new technology and paradigms. For example, most of us still "dial" touch-tone telephones and measure the power of our automobile engines in terms of horses. And the ideas and concepts of science and technology have reached beyond simply changing our language and bringing new meanings to words; they have also provided cognitive metaphors which have influenced how we think, act and lead in our organizations.

In many ways today, we are still behaving and acting under the cognitive model of Newtonian or classical physics. We are trained to work in and lead linear hierarchical organizations; we believe strongly in pre-determinism; and we look to the past to predict the future. And just as the application of Newtonian physics has brought us many wonderful technologies, the use of these principles as metaphors for our organizations has brought us many improvements in our productivity, for example, through the practice of industrial engineering.

Nevertheless, virtually all of the great inventions and technologies of the past fifty years have resulted directly or indirectly from the application of the principles of Quantum physics. Quantum physics was discovered in this century, and describe a world that is quite different from the world of Newtonian physics. As we move forward into a world dominated by these technologies, I believe that principles of Quantum physics will become the new metaphors for more creative leadership and organizational structure in the next century.

For us to understand how these principles might be applied, we must first understand qualitatively the major differences between classical physics and quantum physics. We shall do that by first examining the Newtonian worldview, and then comparing that to the world of quantum physics.

The Newtonian Worldview

In the late nineteenth century, it appeared to the world that the major elements of physics had been discovered and effectively established for all time. The work of Galileo Galilei and Isaac Newton in the seventeenth century had been verified by 200 years of experimental and theoretical science to become "classical physics." Classical physics appeared to have the power to explain and predict the behavior of virtually every aspect of the world: from thermodynamics to moving objects, to optics, gravity, and electricity. Indeed, the world of classical physics almost precisely modeled our physical world.

During the 200 years following Newton, classical physics shaped a worldview that seemed quite tidy; it was the view of the universe as an enormous clockwork. The universe was a grand machine that was ticking away, perhaps after the windings of some God or other supernatural force. The Newtonian worldview was essentially reductionist; that is, everything could be reduced to a finite set of constituent parts. Furthermore, in the Newtonian view, if you knew everything about a system at a given time, you could predict the behavior of that system perfectly and forever after.

At the end of the nineteenth century, Lord Kelvin, one of the most respected physicists of his time, suggested that there were only "two small clouds" remaining on the horizon of physics. These two small clouds the failure to detect the existence of a hypothetical substance called the "ether" and the inability of electromagnetic theory to predict certain distributions of radiant energy led to the "new" physics, the physics of quantum theory.

Newtonian versus Quantum Physics

And the world of the new physics and quantum theory was quite different from the old world of Newtonian physics. It was a world where probability replaced predictability, uncertainty replaced certainty, relativism replaced absolutism, and chaos replaced order. Quantum theory explored the fundamental properties of matter and energy.

Matter and Energy

In the Newtonian view of the world, matter was solid, irreducible, and separate from energy. The great discovery by Einstein, described by his famous equation " $E=MC^2$ " showed that matter and energy are not separate, but are interchangeable. As the late great physicist David Bohm once said, "Matter is simply frozen light." In the quantum world, matter is not solid at all, but consists mostly of empty space in which particles, composed of even smaller particles, travel at close to the speed of light, filling the space and giving an illusion of solidity. And, because there is no way to stop this movement, all matter is in a constant flux of change. Consequently, there is nothing which exists as permanent and unchanging.

Classical physics described light in terms of particles; the experiments of Thomson, Davisson, and Young demonstrated that light and electron beams both have the dualistic properties of both waves and particles, depending on how they are observed. Einstein's theory of relativity demonstrated that a central dogma of classical physics, that there is an absolute frame of reference and that an observed object should not depend in any way on how an observer is moving relative to the object, was incorrect. Thus, measurable properties of an object were not inherent in the object itself, but were dependent upon the time-space relationship between the observer and the observed object.

The theory of quantum mechanics comes from the discovery that small particles, such as electrons in atoms, and photons of light, do not move incrementally, as classical physics would predict, but instead move in discreet units or quanta. Indeed, this is also true at the

macro level, but the quanta are so small as to be unobservable (and recall that which appears as solid is really mostly empty space). Furthermore, when an electron moves from one energy level to another, it does so without ever passing through the space in between! (If it did, we would simply be back to the incremental movement postulated by classical particle physics, only the electron would be moving at a very fast speed.) The term quantum mechanics derives from the mathematical wave mechanics equations used to describe these phenomena.

The Uncertainty Principle

In 1927, Werner Heisenberg described his famous Uncertainty Principle that basically states that there are insurmountable physical limitations on how much information can be known about a given system. (In particular, one could know the exact location of a particle, but then could not know anything about its momentum, or one could know its momentum but then could not know its location. The more precisely that one measured one property, the less one knew about the other.) Thus, the classical physicist's dream of being able to describe a system completely and absolutely was shown to be a physical impossibility.

The Uncertainty Principle further reinforced the fact that a system cannot be observed or measured without disturbing it. Even the seemingly subtlest observations, such as taking a photograph, have an effect, although diminishingly small in the macro world, upon the system being photographed. Although classical physics described how every body of matter has a connection with every other body of matter, through gravitational attraction, it could not describe the more subtle effects that an observer has on an observed object simply through the process of observation.

The dream of deterministic predictability was further shattered by the emergence of the new science of Chaos that showed that apparently random patterns in nature, such as the turbulent flow of a liquid or the weather, could be elegantly modeled mathematically, but not predicted. In these models, scientists also observed that very small perturbances of the system led to large unpredictable changes in the behavior; furthermore, these systems never reached a steady state of equilibrium. The famous description that the flap of a butterfly wing in China causing the monsoons in India has been commonly used to illustrate the cascade of effects that small, seemingly isolated, events play in shaping whole chaotic systems.

Cause and Effect

But what of cause and effect? Causality is still hotly debated among physicists, but in the quantum world, there appears to be a break in the direct link between cause and effect. For example, Einstein's work on the spontaneous and stimulated emissions of radiation by molecules (which laid the basis for the laser) showed that the timing of a spontaneous transition and direction of the emitted light quanta could not be predicted by quantum theory (or classical physics, for that matter!). The probability of such a transition could be calculated, but the timing and direction were seemingly left to chance. In a classical

physics analogy, it is as if I were to drop an object from my hand, yet instead of falling to the ground quickly, it hangs in the air for some unpredictable amount of time before it falls. Although the probability is greatest that the object will fall quickly, there is a small probability that it will hang in the air for several days before it does. The cause for this effect at the quantum level does not appear to exist.

While this has certainly not been an in-depth discussion of quantum mechanical phenomena, it was intended to illustrate the remarkable difference between the two worldviews. As even the brilliant twentieth century physicist Richard Feynman stated, "I think I can safely say that nobody understands quantum mechanics."

But although there is still much that we don't understand about quantum physics (how, why? gravity really works, for example), we do understand how to harness the empirical consequences of the quantum mechanical theory. Virtually all of the great inventions of the last four decades have resulted, directly or indirectly, from using these ideas. But in spite of the fact that our scientists and engineers have applied these principles so elegantly in building new technologies in the past 40 years, the conceptual framework underlying them is only beginning to emerge into our organizational thinking. Considering the difficulty even among physicists to philosophically grasp the concepts underlying quantum mechanics and our immersion in Newtonian physics for more than two centuries, it is not surprising that these concepts have not easily translated into mainstream thinking. In that context, it is easy to understand why the conceptual framework of the new physics was very hard to grasp by an industrialized world that had been revolutionized by inventions based on Newtonian physics, and had, consciously or unconsciously, mapped its organizational structures based on those principles.

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