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Editorial

Reflections of the Chair of the Committee on Science and the Arts

Every April in a ceremony held in Philadelphia, Pennsylvania, USA, the Franklin Institute makes awards to individuals for achievement in science, engineering, and business leadership. In 2005, five of these awards were Benjamin Franklin Medals, a program that has been active at the Franklin Institute for over 180 years. The remaining awards in 2005 were Bower Awards, made possible by a bequest to the Franklin Institute in 1988. The selection of the individuals receiving these awards is made by the Committee on Science and the Arts of the Franklin Institute. In this issue are reports that summarize both the accomplishments of each of the awardees and the significance of their accomplishments to science, engineering, and business.

Reading these summaries is informative and exhilarating. These individuals represent the highest level of intellectual achievement, and their efforts have a made a difference to humankind's understanding of the natural world and to the quality of life for people across the globe. It is not difficult to ascertain the thread that connects these people together. Each found themselves intensely interested in something about nature and could not help but try to understand it better. In many cases the initial interest came early in life and was more a fascination than a well-defined interest. But somewhere along the line this general curiosity became a refined question about the behavior of the natural world. To these individuals, these questions carried great importance, providing the motivation for their work over decades. These people are not only diligent and persevering, but also passionate.

While working on communication systems during the early days of space exploration, Andrew Viterbi could not help but wonder if there might be a way for communication systems to overcome the ever present problems arising from interference and propagation anomalies. Even though the technology of the time did not allow implementation of his ideas, he worked furiously to come up with a mathematical algorithm for digital communication that would make a communication system immune to most interference and propagation problems. When advances in semiconductor electronics made implementation of his algorithm possible and digital communication systems proliferated, the Viterbi algorithm became a part of most systems. For example, cell phones incorporate it to allow for the fact that the propagation conditions depend strongly on location. With the increase in digital communication systems, a way had to be found to allow multiple users to use the same frequencies. Viterbi helped develop the code division multiple access (CDMA) technology to solve this problem and it is in widespread use today.

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As a child growing up in India, Aravind Joshi learned several languages and was fascinated with language in general. As he became professionally trained in the use of computers, he wondered if language could be put into a mathematical form, thereby allowing computers to manipulate language as humans do. His first step was to understand how language is represented in the human mind. The next step was to develop methods that would allow computers to process language. The result of all this work, tree adjoining grammars, allows computers to extract concepts from text, translate from one language to another, and improve their capabilities for artificial intelligence.

In spite of advanced technology, oil exploration in the 1950s suffered from not being able to predict correctly where oil or gas was trapped underground. Extensive studies using the reflection of seismic waves produced by surface explosions revealed a great deal about the underlying rock formations, yet drilling at a location where the reflections were similar to those at a productive oil or gas site did not yield oil or gas in many cases. Peter Vail wondered just what the reflection studies revealed about rock formations, and after a good deal of work, concluded that the seismic data could be used to extract a time line for the formation of the various subsurface rock formations. This understanding led to better decisions on where to drill for oil and gas, but he could also compare the formation time of rock formations across the globe. When this information was collated, Vail realized that the data represented a record of sea level changes over geologic time, thus revealing in much clearer detail an aspect of the Earth's history.

Yoichiro Nambu was always interested in mathematics and physics, but when he began conducting research into the fundamental laws of nature, only the deepest and most important problems caught his interest. Why is the number of elementary particles what it is? Why are there different types of elementary particles? One of Nambu's answers to such questions was that under certain conditions, different types of elementary particles are really the same particle. This fact represents a symmetry of nature, which is spontaneously broken when conditions change. Nambu also recognized that the behavior of quarks necessitated that they possess a specific property, moving the field of quantum chromodynamics forward by a giant step. Nambu was also one of the first scientists to investigate if describing elementary particles as vibrating strings might lead to a better explanation of their properties.

Being curious about almost any living creature she could get her hands on led Elizabeth Blackburn to a career in cell biology. As countless scientists noticed, Blackburn was aware that there was a special feature at the ends of chromosomes called a telomere. But she did not just notice telomeres, she asked what their structure might be. Surely they serve an important purpose, but what is it? When she finally sequenced the DNA in a telomere, the result was very puzzling. Instead of coding for an important protein, the DNA was a succession of repeating sequences that seemed to serve no purpose. It took more hard work to figure it out, but Blackburn finally realized that these repeating sequences were actually protecting the chromosome during replication. Since it is not unusual for a small amount of the DNA at the ends of a chromosome to be lost in the replication process, these repeating sequences were being sacrificed so the rest of the chromosome remained intact. The implications of this discovery were enormous, lending new insight into the understanding of both the aging process and cancer.

The fact that many biologically important molecules come in right- and left-handed versions is extremely important and there has always been a high demand for the chemical synthesis of only one version of a molecule. In spite of this urgency, for a long time the standard method remained the synthesis of both versions at once (normally not difficult), followed by techniques to separate one version from the other (normally very difficult). Henri Kagan was convinced that just as living organisms can synthesize one version, it must be possible to synthesize one version in the laboratory. As he worked to develop new techniques, progress was extremely slow. Yet he endured and found that by using the proper catalysts, the synthesis of one version could be done. This procedure is called asymmetric catalysis, and is important for drug production, food processing, and agricultural products.

If you want an intelligent and hardworking person to be productive, give them the necessary tools and leave them alone. Alejandro Zaffaroni did everything he could as a young researcher to find such an opportunity for himself, and later in life made this the principle for the technological innovations that he directed. For example, Zaffaroni was concerned that normal drug delivery dumps a high dose of a drug into the organism, and then supplies nothing until the next large dose is supplied. Would not drugs work better if they were delivered as hormones are secreted, gradually over time? The result of his efforts was the trans-dermal patch, a method used to deliver many drugs at present. Zaffaroni continued to follow the pattern of identifying capable young researchers and giving them the freedom to follow their ideas. He helped start many companies, knowing full well that the path to business success is via technological innovation. In this process, he invented the venture capital model for start-up companies long before the craze of the 1990s.

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