**LANGUAGE IN THE TWENTIETH CENTURY**

Nov. 10, 2003

**Dear Friends in Cardiac Rehab:**

This is my annual birthday letter for age 98. I would like to write about the 20th century, which was my century. I have spilled over into this new century because in 1905 I was late arriving for mine. My century brought in new ideas, customs, institutions, life styles, science and technologies that we now take for granted, as well as the worst war in human history. Here I would like to recall very briefly some selected things from it, and then bring them together in the general concept of language, which I think distinguishes not only my century but also the human race itself.

Since I shall have some harsh things to say about religion as law, government or knowledge, let me hasten to explain that for twenty years I was completely immersed in the religion of my minister-father and my devout mother; and I retain my love and respect for their religion. What has happened to me is that I have broadened that respect to the religions of good people the world over.

For example take the free public high school. In the 19th century eight grades made up the free public education. Those who could afford it prepared for college in private academies. Those who could not had to prepare themselves by private study. Of course, not many could do this. But, in a process extending from 1893 to 1913, the free American high school was established under local school board control, and its relation to college defined. This added four more years to universal education in this country. High school and high school graduation have become an essential tradition in the life of every one of us. And the number of young Americans going on to higher education has been increasing aver since.

On a grander scale I believe that the 20th century may have seen the end, at least in our society, of a long history of government by religion. The control of governments by religion has brought untold ruination to civilization throughout the ages. For example, the conversion of Rome to Christianity ended the great Greco-Roman classical civilization, and brought on the Dark Ages. An Arab civilization emerged as world leader in science around the 8th century, particularly in astronomy and in the introduction of our number system, only virtually to disappear under Muslim control. And China, up to the Ming dynasty beginning in the 14th century, had a great tradition in technology and art, which was stalled by the emerging dominance of Confucianism with its ancestor worship.

The Renaissance during the 13th, 14th, and 15th centuries took Europe out of the Dark Ages with its walled cities. But the Protestant Reformation of the 16th century set up a multiplicity of church-related governments in Europe, which brought on more wars. This led our forefathers to establish the principle of separation of church and state in our constitution to avoid all of this trouble with religion in government. Muslim society has not reached the even first stage of Renaissance and is still in its Dark Ages. European societies have passed into a modern society that is, in effect, a continuation of the Renaissance, but most have not followed America into separation of church and state.

This history leads us to recognize a great contribution of the 20th century, one that belongs primarily to the realm of the so-called humanities. It has turned out that separation of church and state is not enough to assure individual liberty. Separation of

church and state must be made effective by a practice of broad tolerance. This requires that we allow different religions, ideas, or philosophies, to persist side by side, without having to make a uniform choice between them, or decide which one is right for everybody. This tolerance extends to our whole society and defines the way we get along together. It is the great gift that America, France, and Britain made to world civilization in the 20th century.

Of course not everybody has embraced this tolerance. There are still those who are sure that only their own beliefs, derived from their literal interpretation of the bible, are true. We call them fundamentalists, and we tolerate them too. They have a right to believe what they choose, but no right to impose their beliefs on us or on our government. Still fundamentalism persists as a difficulty for us.

This intellectual tolerance is also important in science, not only for the progress of research, but also for the common man's understanding of it. The idea of different, but equally valid mathematical models has been helpful in this. For example, we are familiar with the weather forecaster on TV saying: "According to this model we have the following prediction. But according to another model we must expect …"

I can remember when even scientists had not reached this level of sophistication. Up to the end of the 19th century physical scientists had been comfortable with the laws of motion due to Newton in about 1700. Even the late 19th century idea of atoms could be accommodated in it. Then in 1905 came Einstein's relativity, which took a different, in many ways contradictory, view of motion. Many scientists of the time thought that, since Newtonian theory and relativity could not both be right, they had to decide which was right. But we don't take that point of view now. Here is where tolerance comes in. We use the simpler Newtonian mechanics for ordinary motion at velocities much less than the speed of light and gravity. This is what we math professors teach in calculus. And we use the more exact, but more complicated, relativity to explain situations that involve ordinary motion in the same framework with radiation at the speed of light, or to explain the structure of the universe.

Both of these were theories based on a model of continuous space. But at the beginning of our century the physicist, Planck, showed that, at the atomic level, we must use a theory of discrete quantum differences, not continuity. So we keep all three theories, each one for its special purpose. Einstein never gave up trying to find one general theory that would include all of them, but he did not succeed. Only late in the 20th century have some theoreticians produced a single general theory that claims to include all of those diverse physical theories. It is called *String Theory*. You may have seen recent television programs that attempt to explain it to us mere mortals.

The study of the stars is another one that broke into a new and vastly different stage in our century. Since ancient times men have been fascinated by the stars. Our names for the individual stars and the constellations in which they appear to be organized are either those of the ancient Greeks or those of the Arabs in the 8th century A.D. In about 1600 the study of the stars' positions, their distances, and their arrangement in constellations was made much more precise with Galileo's invention of the telescope with its magnifying glass lens. But there astronomy remained, except for refinements and extensions, up to about the end of the 19th century.

Then at the beginning of our century Planck's quantum mechanics opened up the possibility of analyzing the spectrum of a star's light to identify chemically the

substances of which it is composed. This required a transfer to reflecting parabolic telescopes to avoid absorption and distortion of the light by the glass lens, and to photographic observation which is much more sensitive and broader in spectrum than the human eye's. Then, as larger reflectors were built, each larger one extended the range and sensitivity of observation. Astronomy has not been the same ever since. It has changed from being only a surveyor's mapping of the skies to deriving far more information about its individual members, astrophysics. In particular, the spectrum of an identifiable substance in the light from any star is shifted towards the red end from the spectrum of the same substance in the laboratory. This phenomenon is called the *red shift*, and is interpreted to mean the star is moving away from us. Hence the *expanding universe* and its beginning in the *Big Bang!*

Most of the stars were pinpoints of light, but there were those sort-of smudges, called nebulae. What were they? I remember attending a lecture by Harvard astronomer, Harlow Shapley, explaining his view of what they were. It later turned out that he was wrong. Soon after that, in the 1920's, Edwin Hubble proved that each of those nebulae is galaxy of a vast number of stars! More precisely, astronomers have identified a number of different types of previously unknown objects out there; and the universe is now seen, not as a static structure, but as an ever developing one, with new stars being formed and old ones dying. Our perception of the universe keeps getting unbelievably bigger and more complex. Now astronomers are talking about the possibility of other universes out there, maybe right around us, that our present instruments cannot detect.

In biological science things took a different course. Late in the 19th century two pivotal break-throughs emerged in our understanding of life. In 1859 Darwin published his scrupulously documented *Origin of the Species*, showing how the existing species of plants and animals had evolved over time from lower forms. And in 1866 Mendel published his studies on the distinct varieties of pea plants, showing how these forms were preserved from generation to generation in statistical proportion. It was the origin of the science of genetics, although Mendel did not use that word, or the words, *gene* or *mutation*. Both of these were introduced in the early 20th century when the processes of heredity began to be better understood. Now through popular television all of us are familiar with the roles of genes, and with the description of their positions in the structure of the DNA molecule, particularly that of man himself. This story has aroused wonder, but no outrage over its clash with previous ideas.

The fundamentalists' reaction to Darwin's ideas was an entirely different story. According to them the Bible said that God created man in his own image. That gives us humans a special status, one with dignity. And now here came this scientist, Darwin, who said that we are descended from a monkey. There is no dignity in that. So out with Darwin and his monkeys! And out with science that produces nonsense like that! The idea that the theory of evolution implies a conflict between science and religion is still out there. But Darwin himself remained a Christian. His evidence was overwhelming that mutation and evolution were God's methods of producing different living species.

That still does not answer the fundamental question: What is life? A basic property of living organisms, both plants and animals, is to reproduce themselves. So at least part of that question is: How is a particular living thing made? What is it made of? The answer to such a question is *information*. So life and information are intimately

associated.  Experimental scientists sought the answers first in simple species, such as bacteria and the fruit fly, Drosophila.  They first found that.

These are just a sample.  And besides sciences, there are the new *technologies* of our century.  I think of a technology as a way of applying science to do something or make something.

INFORMATION AGAIN.