Science and Values: Overall View of Science and the Ideals of Human Civilization

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Abstract

If you look at the truth from a certain aspect, you might lose the complete picture. The reason that modern science has progressed is because a certain aspect of the truth was taken and researched in depth. But as a result, the overall picture became unclear. Therefore, the integration of various sciences is again being called upon. A transdisciplinary approach among sciences is required for their further development. Cross-talk among the sciences, the arts and religions should be encouraged, to realize the ideals of human civilization.

The achievements of and methods in science are the major foundations for realizing the ideals of human civilization. It should be noted, however, that the achievements of science have been and will be incomplete. But we should keep on striving for completeness.

The universal viewpoint in science prevents human beings from falling into prejudice and self-righteousness. We need to respect and learn from nature much more. Every existence in nature is organically connected, being neither independent nor dependent, but interdependent. The same is true of every existence in the ideals of human civilization.

My presentation is titled “Science and Values: Overview of Science and the Ideals of Human Civilization.” This topic is too broad in scope to be covered in 17 minutes, so I will try to focus on the essence.

The official name of ICUS is International Conference on the Unity of Sciences, and as the name implies, its goal is to unite sciences. Now in the 20th century, we hear about ‘Structuring knowledge’ and ‘Trans-disciplinary Science,’ but ICUS started back in the 1970’s already. The founder, Rev. Sun Myung Moon, said, “Without the unity of sciences, we cannot reach the truth or solve the problems that humanity and society carries." Therefore, it is a very far-reaching concept, and the fact that many experts of various fields gathered at this conference today is extremely significant.

If you look at the truth from a certain aspect, you might lose the complete picture, but for people to understand and pursue various things, taking things from a certain aspect is inevitable. The reason that modern science has progressed since René Descartes (1596-1650) and Francis Bacon (1561-1626) in the 16th and 17th centuries is because a certain aspect of the truth was taken and researched in depth.

But as a result, the overall picture became unclear and now we don't even know what the field next door is doing. Therefore, the integration of various sciences is again being called upon. In particular, when it comes to basic research, you might imagine it as digging deeply into one theme, but in order bring one’s research to a deeper level, it is sometimes necessary to at some stage expand horizontally. I think profound research becomes possible when there is “interaction with different fields through horizontal development.”

Figure 1 outlines the relationship between the ideals of human civilization and science. Human beings have two kinds of desires: “physical” and “spiritual.” Physical desires seek physical values, namely, good food, good clothing and good shelter, which enable us to live in a comfortable physical environment. We feel happy when our physical desires are fulfilled in such an environment. This is what I call “material civilization.”

However, we cannot be happy by satisfying only our physical desires. This is because we also have spiritual desires. They involve the three functions of intellect, emotion and volition. Each is paired with spiritual values, namely, truth, beauty and goodness. Science is the method, or means, by which the intellect seeks truth. Art is the arena in which emotions seek beauty. And religion is where volition, or the will, seeks goodness. We feel happy when spiritual desires are fulfilled in an environment in which truth, beauty and goodness abound and develop in harmony. I call this type of environment “spiritual civilization.”

I would define the ideals of human civilization as states in which both the material and spiritual civilizations are realized. This paper focuses on science and science-driven technology in relation to the ideals of human civilization.

Over the course of its development, science has been divided into many different disciplines, which may be placed in three major categories: natural science, human science and social

science (Figure 2). Natural science includes the disciplines of physics, chemistry, biology and more. In addition, each of these disciplines is further divided into specialized subdisciplines.

Figure 3 explains the development of natural science and science-driven technology. Recall that science is a method by which human beings overcome ignorance and seek truth. History includes geniuses who have made major breakthroughs in science, such as Aristotle, Maxwell, Newton and Einstein. Nonetheless, we remain a long way off from knowing the entirety of truth. There are many things yet to be investigated and understood.

The right side of Figure 3 shows the process of science-driven technology, overcoming our primitive state and realizing an advanced and comfortable material civilization. I will focus on natural science, shown on the left side of the figure.

Since ancient times, human beings have struggled to find answers to three major questions: First, “How did the universe begin?” Second, “What are the elements that compose the universe?” Third, “What is the origin of life?” These three questions have not yet been answered, indicating that we are still far from understanding the whole truth.

Figure 4 shows the 13.8-billion-year history of the universe, which started with the Big Bang expansion, in relation to fundamental physical forces. In our understanding, there are four fundamental physical forces in the universe. They are the electromagnetic force, weak force, strong force and gravitational force. The electromagnetic force is very familiar to us: it is widely utilized in our daily life in the form of many electric and magnetic devices. Another force familiar to us is the gravitational force, which governs the movement of planets as well as the falling motion of things on earth. The two remaining forces — weak and strong — are not familiar to us because they function in a world much smaller than even atoms. However, they play very important roles, and our universe would not exist without them.

At the frontier of science, it is assumed that in the beginning, the universe was far smaller than even the size of an atom. In the beginning, the temperature of the universe was one trillion multiplied by one trillion multiplied by 100 million degrees Celsius — an unimaginable number. In such a world, the four different forces were presumably unified as one force and ruled by one common law. This assumption, however, has not been experimentally tested. It requires both experimental and theoretical research. This question is closely related to the question of how the universe began, which is why it is so important.

The second question is, what are the elements that compose the universe? Until about the end of the twentieth century, we thought that the universe was composed of atoms, light and nothing else. Here, “atoms” means all kinds of elements, which are listed in the Periodic Table of Elements. In the twenty-first century, however, we have come to realize that some things of unknown composition, called “dark energy” and “dark matter,” are the main constituents of the universe (Figure 5).

The atoms that we know compose only 4.6% of the universe. With- out the premise of the existence of dark energy, we cannot explain the experimentally observed fact that the universe is expanding at an accelerating speed. At the same time, we know that the revolving

galaxy in which our solar system exists would be disintegrated by the centrifugal force, so it is assumed that dark matter must exist. The quantities estimated amount to approximately 70% and 25% of the whole universe, respectively. However, because they are not visible in light, their reality has hardly been understood at all. That is to say, we don't understand what elements compose most of our universe.

The third question is, what is the origin of life? Owing to time constraints, I will not go into this subject. Nevertheless, it is no exaggeration to say that we are still not able to answer this question at all.

In spite of the remarkable advancements in the natural sciences, we have not reached the stage where we can answer the basic questions that people in primitive ages must have wondered about. This reminds us of a statement by Sir Isaac Newton as follows: "I do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the seashore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me." This is science!

Next, let me talk about scientific methodology. The primary method in the scientific pursuit of truth involves observation and rationality (Figure 6). Through observation, we can discover certain features, patterns and regularities inherent in the natural world. Then, by applying rationality, we can set up a hypothesis for a law that may explain them. In general, scientific truth is a hypothesis requiring the following conditions: Does the hypothesis have any contradictions with the current knowledge system? Is the new hypothesis "beautiful" and capable of answering many essential questions with "simple" assumptions? In science, a set of hypotheses is developed in a spiral fashion, producing a law that does not have contradictions. Accordingly, scientific truth develops with history. In addition to observation and rationality, human inspirations play a critical role. Methods of observation and rationality may facilitate the process of ascertaining whether a particular inspiration is reasonable or not.

One of the crucial aspects of science is that it offers a universal viewpoint that can prevent human beings from falling into prejudice and self-righteousness (Figure 7). Scientific laws and equations are acceptable if they prove valuable even when described in different coordinate systems. Examples include: Newton's laws of motion on the macroscopic scale, the laws of quantum physics on the microscopic scale, Maxwell's equations in electrodynamics and Einstein's theory of relativity. All of them have been accepted because they are valid in different coordinate systems.

Sometimes the same thing looks different from a different viewpoint. For example, Figure 7 has a picture that looks like an old lady, but if you turn the picture upside down it looks like a young lady. This has something to do with observation. Certain laws would be more universally acceptable if they are found to be true through observation even from different points of view. This relates to my earlier argument that consistency of observations from various viewpoints and rationality are crucial. I don't deny an individual's "personal view-points." However, in human society, prejudice and self-righteousness based on an illusion

from a particular viewpoint could cause strife, even with no malicious intent. This is why the universal viewpoint in science is vitally important to realize the ideals of human civilization. Human conflicts occur when people insist on their own viewpoints, but science effectively attempts to unify different ideas, offering precious suggestions as we pursue the ideals of human civilization.

Next I will touch upon “common assumptions” in science. Somewhat akin to hypothesis, they may be termed as “common assumptions” in science as they had proved true after verification from various angles. Some examples of “common assumptions” in science are as follows: the law of energy conservation, the law of entropy increase, causality, constant velocity of light in a vacuum under an inertial frame of reference and so on. Although, there remains the possibility that these common assumptions in science will be updated in the future, they have played significant roles in the pursuit of truth.

Let me briefly address the issue of causality and correlation. Science has a role to clarify the relationship between two different concepts. While somewhat akin to each other, the concepts of causality and correlation refer to different relationships. In causality, A causes the effect B. In a correlation between A and B, A does not cause B, but both are the effect of unknown X, which may turn out to be the true cause of A and B. Many people confuse causation with correlation; we need to understand that they are two different concepts. For example, there is still a debate whether the rising level of carbon dioxide in the atmosphere is the very cause of global warming. Some people think that both phenomena are the result of some unknown factors. Do we know if it is a causal relationship or a correlation? Whichever it is, we need to reduce the consumption of oil and coal, because their abundance in the earth is limited.

Now consider some solutions to the energy problem. By applying science and science-driven technology, we have the possibility of solving the energy problem through the development of new devices. They include devices to produce energy, transport energy, store energy and save energy (Figure 8).

Today, energy production relies mainly on hydropower stations, thermal power stations and nuclear power stations. However, with the development of new technologies in the future, we could rely on artificial photosynthesis systems, photovoltaic power stations, or thermo-electric devices, without producing carbon dioxide.

New devices may be developed to transport energy, including high-temperature superconductivity and advanced methods using ammonia, hydrogen and hydrocarbons as energy carriers. As for devices to store energy, second batteries and thermal storage devices are being developed rapidly.

Regarding new, energy-saving devices, research and development of fuel batteries are being intensively carried out, to replace car engines with electric motors. The LED (light-emitting diode) is also an innovative device to replace the conventional light bulb.

My research is related to the development of energy-saving vehicle tires. In the photograph in Figure 8 (bottom left corner), high temperatures are indicated by the red areas, which are wasting energy. With energy-saving tires, we can greatly reduce fuel consumption.

Figure 9 shows the rates of resistance when a vehicle is running, including wind resistance, mechanical resistance of the entire vehicle and resistance from the road's surface against rolling tires. Energy loss associated with the rolling resistance of the tires amounts to approximately 20%. If we could reduce the tires' rolling resistance, we would reduce fuel consumption.

Vehicle tires are made of rubber, whose original color is white. However, almost all tires today are black (Figure 10). The reason is that carbon powders are added to tires in order to increase their strength. Without carbon powders, tires would be like rubber erasers that fall to bits by friction. Another reason for adding carbon powders is to achieve vital but seemingly contradictory capacities necessary for tires, namely, to enhance fuel efficiency by reducing the tires' rolling resistance as well as to enforce their gripping power (traction) when the brakes are applied.

The lower part of Figure 10 shows a microscopic image of the kind of carbon powders mixed into tires. Using a high-brilliance synchrotron radiation source and the X-ray diffraction method, we have investigated the relationship between the performance of the tires and the carbon powders' clump sizes and mixture ratio. By analyzing the outcome of the experiment, we have succeeded in illuminating the sizes of carbon powders and their mixture ratio that would best enhance fuel efficiency and the gripping power of the tires.

For this research, we used the facilities shown in Figure 11: an "X-ray Free Electron Laser Facility," a 700-meter-long SACLA and a high-brilliance synchrotron X-ray radiation source, SPring-8, located in Japan.

The result of our research is shown in Figure 12. On the left is a conventional vehicle tire and on the right is the new product being developed based on our research. The energy loss from the tires' rolling resistance has been dramatically reduced through our research, which is being done in collaboration with Sumitomo Rubber Industries, Ltd. This achievement may be one small step, but it will be one giant leap for mankind if these types of small steps are integrated through various research activities.

Finally, looking back at Figure 1 regarding the relationship between science and the ideals of human civilization, we can add and emphasize the following points (Figure 13):

- Unified human intelligence is needed.
- Science is always incomplete, but we must strive for its completion.

To summarize, allow me to make the following points:

- If you look at the truth from a certain aspect, you might lose the complete picture. The integration of various sciences is again being called upon.
- The achievements of and methods in science are the major foundations for realizing the ideals of human civilization. It should be noted, however, that the achievements of science have been and will be incomplete. But we should keep on striving for completeness.
- The universal viewpoint in science prevents human beings from falling into prejudice and self-righteousness.
- Science-driven technology has two-sided effects.
- We need to respect and learn from nature much more. Every existence in nature is organically connected, being neither independent nor dependent, but interdependent. The same is true of every existence in the ideals of human civilization.
- A transdisciplinary approach among sciences is required for their further development.
- Cross-talk among the sciences, the arts and religions should be encouraged, to realize the ideals of human civilization.

Albert Einstein famously said, “Science without religion is lame, religion without science is blind.” The development of science is important, but in this age, more important is human development — that is, the development of human beings themselves (Figure 14). We, human beings, need to grow up to be “true human beings” who have the capability to govern ourselves and the universe through the well-balanced development of science, art and religion. A bright future definitely depends on this development.

Thank you for your attention.