

# AN EXPERIMENT WORTH TRYING

*An Introduction to The Far Reach of Science.*

by *Lee A. DuBridge*

WE are here to try an experiment. It is the essence of any experiment that its results cannot be predicted; otherwise it is not an experiment, it is only an event. Since we are always doing experiments at Caltech, we are willing to try this one.

The nature of the problem this experiment seeks to answer is simply this:

Can we as scientists bring to a group of business and professional leaders who guide the practical affairs of this country, and who have no professional concern with science, some insight into what modern science is all about and why it is important to every person on this planet? I don't know whether we can or not. But we firmly believe it is worth trying.

The advance of science in the past 300 years has had a profound effect on the way human beings now live and think. There is no moment in your life that you are not doing things, thinking things, using things that were unheard of or impossible to think about 300 years ago when modern science began. The food you eat, the clothes you wear, the medicines you take, the way you travel, the way you communicate with others, the products you make or sell, the industries you operate or invest in or persuade others to invest in, the way you think about the world—all of these things are new in the past 300 years or at least have been profoundly altered by scientific knowledge and understanding.

A handful of scientists plus a somewhat larger handful of engineers and technologists have radically changed the nature and quality of human life. Our ways of thinking have been altered too, because today we think not on the basis of superstition but on the basis of at least *some* understanding.

I am not suggesting that the nature and quality of human life is all that we would like to see it. But I am suggesting that, because we have much knowledge and because we are so rapidly acquiring more, the process of changing the quality of life is today under our control. This was not true 300 years ago or even 100 years ago. And it is not as true today as it will be in the decades and centuries to come. But it is sufficiently true today to suggest that all of us should be aware of the nature of the process of advancing the knowledge which is making it technically possible for us to make our dreams come true—or possibly, by inadvertence, fail to make them come true.

The human being is the one animal equipped with a brain capable of abstract thought. The brain is, in fact, man's principal instrument of survival. So it is not surprising that a prime urge of an animal with such a brain is to use it to acquire knowledge, to attain understanding, and to find ways of using his knowledge to make his life a better, safer, and fuller one.

We know that man's curiosity about the nature of the world he lives in is as old as man himself. Before the dawn of recorded history man looked at the stars, speculated about their nature, and plotted their motions. He looked at the world around him—at the wind, the rain, the earth, the sea, the heat, the cold, the burning fire—and he puzzled about these things. He puzzled also about himself, about birth and death and sickness and disease. He asked many questions: Why do the winds blow, the rains fall, the stars move? He asked also: How did it all begin? How will it all end?

Early man proposed many answers to these questions, and often the answers became a

part of his religion or his philosophy of life. Indeed, what we now call science was once called natural philosophy, as distinguished from moral philosophy.

In view of the fact that man's penchant for speculating about the nature of things is so ancient, it seems remarkable that only moderately recently in human history did man finally discover a systematic way of answering his age-old questions and discovering the how and why of nature.

It may be even more surprising to realize how far man has progressed in that 300 years since science was born. For when Galileo first measured—not just looked and speculated, but measured—how bodies fell to the earth and when Newton enunciated the general principles which he found to govern these phenomena, mankind entered a new and exciting era.

The scientific endeavor has had an extraordinary history. Every now and then someone who is overly impressed by what has been learned has had the bad judgment to suggest that now we know it all, that the progress of knowledge is finished, and that the world is at last fully understood.

This was said by distinguished people at the beginning of this century. How fabulously mistaken they were! For every year the acquisition of knowledge has, in fact, accelerated. New discoveries have been made, new mysteries revealed, new tools for asking new questions of nature have been invented. And so today, while we perceive a vast sea of knowledge behind us, we see an even vaster sea of ignorance ahead.

But that sea of ignorance no longer frightens us; it challenges us to new ventures. For we now know that, bit by bit, knowledge will replace this ignorance.

The depth of our ignorance is suggested by the three basic questions that we are going to be dealing with in this symposium:

What is the nature of the universe?

What is the nature of matter and energy?

What is the nature of life?

About each of these questions much is known, but also there is much that is unknown. And the efforts to explore this unknown are more energetic and productive today than ever before.

What is the goal of all this effort? The goal

is simply understanding—learning the facts of nature's behavior and trying to comprehend the principles that underlie this behavior.

The principles that one seeks are, of course, more important than the facts that one finds; for tables of facts in themselves are sometimes pretty useless. You can have all sorts of statistics about what is going on in the world, but unless you have some general concepts which correlate and make the statistics meaningful, you do not have understanding. But when we *do* understand the laws which underlie the facts, the facts come to life. What is more, only then can we predict the relationships between facts and new facts, and only then can we predict with confidence the future behavior of nature.

Because we know the laws of motion and gravitation with astonishing accuracy, the trajectory of a spacecraft headed for Mars can be predicted and come out very close to the prediction. Because we understand the laws of electromagnetism, we can predict with precision and confidence the behavior of a new electric power plant or a television transmitter. Because we understand quantum mechanics, we can understand the behavior of atoms and molecules, including the very complex molecules that make up human beings. Because we understand a small number of basic principles, we see the unity of science. We see that the laws which govern the most distant galaxies are the same as those which govern the behavior of living cells and of the atoms and molecules of which they are made.

And that, I trust, will be the principal lesson for today—that science and its companion technology are not many unrelated subjects; they are one.

Once these three branches of science—the universe, the atom, and life—seemed to have very little relation to each other. But today we know better. These three fields are unified by a comprehensive set of principles which ties them all together, which makes sense out of the knowledge we have acquired, and which makes possible a more systematic quest for new knowledge.

We don't understand it all, but we do understand enough to see the unity of these basic principles and know that more basic principles await our examination and discovery.