

# EXPLORING THE UNKNOWN

**In the end, this is the way we will conquer fear  
—by continuing to explore the unknown in  
every field of human endeavor.**

by L. A. DuBRIDGE

**I**NDUSTRIAL RESEARCH in America today is, taken all together, an enormous and far-flung enterprise. It must account for the expenditure of between 3 and 4 billion dollars a year, of which the Federal Government supplies about one-half. Hundreds of thousands of scientists, engineers and technical workers are engaged in it. There are products of such research which were unknown 20 years ago but which today account for substantial fractions of the income of many companies—and the entire income of some companies.

Yet, 20 years ago industrial research was still only an adolescent. Forty years ago it was a mere child and 50 years ago it hardly existed at all. Now 50 years is not a very long span in human history. From the long-term view, industrial research has literally exploded into being in a miraculously short period. Why did it not begin sooner?

The answer to that is simple. Industrial research is, I take it, the process of putting scientific knowledge to work for the purpose of developing new industrial products and techniques. Scientific knowledge thus had to exist before the exploitation and use of such knowledge could come about. But the scientific knowledge of, let us say, the theory and structure of atoms and molecules — on which much of the modern chemical industry is based — was only coming into focus 40 years ago. The electron and X-rays were discovered less than 60 years ago; radio waves are 67 years old; the decisive discoveries on the nature and behavior of electricity were made by Faraday only 110 years ago. And, for that matter, modern science itself came into existence less than 300 years ago. It was then that Newton put together the observations of Galileo on rolling marbles, of Tycho Brahe and Kepler on the motions of the planets and deduced the

first great theoretical principles of physical science: the laws of motion and of gravitation.

After thousands of years of civilized history, it was not until the 17th Century that man finally uncovered the fact that nature operated in accordance with laws that could be discovered; laws that were so exact that they could be used to predict with precision the behavior of physical bodies. And at the same time men were uncovering these startling regularities of nature — the grand and beautifully simple laws which nature obeyed — they also discovered the infinite complexity of nature; that there were undreamed-of phenomena awaiting discovery — for those who were willing and able to explore.

And so it was that during the past 300 years scientific knowledge slowly came into being until, at the beginning of the 20th Century the time was ripe for the explosive rise of applied science.

Now this development of applied science has been one of the most spectacular phenomena of our generation. It has revolutionized our way of living — and possibly also, our way of dying. It has transformed the lives of millions of people, and has elevated their hopes and ambitions too. Science has become the new “magic” — it is, some people seem to think, capable of doing anything.

And yet there are disquieting notes mixed in with the growth in public acclaim for applied science. The refrigerators and toothpaste are appreciated and enjoyed. But the scientific knowledge which made all these things possible is forgotten or ignored. The latest gadget for better living is promptly purchased on the installment plan. But when someone mentions weapons for defense, a great cry goes up: “The scientists are trying to destroy us.” In fact, in these days it has

become fashionable in some circles to say we have had "too much science"; that "science is the cause of most of the world's troubles"; that we ought to "return to the liberal arts"; that science ought now to wait a while so that social science can "catch up." The idea is, presumably, that social science or the liberal arts or something will then teach us all how to love one another so that human beings won't end up by atom-bombing themselves off the face of the earth!

To hear some people talk, you would think that science causes nothing but unhappiness, conflict, war; that science denies the finer things of life; is too "technical" to have a place of respect in modern education. You would think that the fate of the world rested on the outcome of some sort of a race between scientists on the one hand and all the historians, philosophers, writers, economists, poets, preachers, and political and social scientists on the other, with the implication that if science wins, the human race will be blasted to oblivion.

### Anti-science

Some people talk as though they really believe some or all of these things. In fact, there are some very important people who are making it their business to promote these ideas. I think it is time that we, the scientific community, began to do something about the attacks which have been made on science and on scientists. For they are having profound and even terrifying effects. They have already caused an alarming drop, for example, in the number of high school students who take mathematics and physics. They have caused many a serious-minded college or university student to avoid all science courses and to look with disdain on those who major in science fields. They have caused well-meaning people to believe that scientists are necessarily so specialized and blind as to be wholly untrustworthy the moment they step out of the laboratory, and to class all scientists and engineers as "narrow-minded technicians."

How then do we go about meeting these charges, these misunderstandings and prejudices?

First, I want to say that I do not think the way to do it is to brag more about the gadgets and devices and weapons which have come about as a result of the systematic attempts to make use of scientific knowledge. I have great admiration for deep freezes and bulldozers and jet airplanes and detergents and penicillin — and even pink and white Cadillacs. But the values of science really do not lie in these things in themselves. Rather, they lie in the way in which pure and applied science contribute to man's physical, intellectual and spiritual well-being. The true values of science lie not in its by-products, but in its goals; not in its dollar value, but in its human value. The value of science will be judged not by how fast it helps us to travel, but where it helps us to go.

In order to get a better look at this problem, I think

we should forget about applied science for a moment and think about basic science, the pure search for knowledge.

First let us ask why men *are* scientists. Why do some men spend their lives in pure science? Well, I can assure you it is not because of any desire to destroy the world or even to harm a single human being, or make him less happy. Quite the contrary! Nor is the scientist usually impelled primarily by a desire to make money— though I am sure he looks forward to receiving the monthly paycheck as much as anyone (especially when the fresh PhD today can go out into his first job at \$10,000 a year).

On the other hand, I can't claim either that the scientist's objective is wholly or primarily an altruistic one — trying to make the world over into a Utopia, for example. He simply hopes that his work will be some contribution to human welfare.

Primarily, it seems to me, the scientist is impelled by certain basic human urges. One is the urge to explore. The spirit of Christopher Columbus, of Magellan, of Admiral Byrd; the spirit of all those who have first discovered unknown places or climbed unconquered mountains — such a spirit is in each of us to some extent. It is certainly in every scientist, even though few of them have bothered to recognize it.

Another common human urge is the urge to create. Every human being would like to create something new. Just look at the "do-it-yourself" business! Some people create music or poetry; some create beautiful pictures, fine statues, magnificent buildings, exquisite furniture or jewelry or clothing. So too, a new discovery in science is a creation — and in the eyes of scientists it has a beauty and an elegance all its own. To be able to contribute, even in only a small way, to the building of the magnificent edifice which we call science is a great creative satisfaction.

Add to the urges of exploration and creation the urge of competition — the desire to be the first to find a given piece of knowledge — and one has a good description of a scientist's motivation.

### Public understanding

How can it be then that the structure of science, which results from such almost purely aesthetic motivation and which is admired by the scientist as a thing of beauty and a joy forever, can be looked on by the general public as an ugly, mundane, or even dangerous product? It is true, of course, that some works of art are admired only by the artist, and the artist then complains that the public doesn't "understand" his work. So I guess the scientist also sighs that the public does not understand *him* or what he does. But, if science is to have the surging vitality that it should have in modern America, the public should understand science.

Our usual attempts in this direction, however, are often inadequate. We usually try to explain the value of science not by telling why it is beautiful, but only why

it is *useful*. Hence, the public concludes that scientists are materialists, that they are mere technicians, specialists, unaware of the finer things of life!

Now, explaining why a thing is beautiful is much harder than explaining why it might be useful. Yet it is worth trying. We can be encouraged, I think, by the great public interest in astronomy. Everyone knows that the Palomar 200-inch telescope has no very "practical" uses. Yet thousands of people journey to Palomar every month to see that magnificent instrument and to hear about the awe-inspiring picture of the universe which it is revealing. Exploring the universe is an adventure which almost anyone envies and admires. And the beauty and grandeur of the universe is at least dimly visible to almost everyone who cares to listen and to look at pictures.

However, I claim there is an equal beauty and grandeur to the picture of an atom of iron or copper or uranium which modern science has revealed. Even more beauty, perhaps, is to be found in the structure of a protein molecule. More still is in the structure of the gene as it is built up of spirals of nucleic acids all so ingeniously designed that the gene can make a copy of itself — can reproduce its kind. With all due respect, I claim there is as much beauty in such things as can be found in great paintings or fine literature or music.

Am I crazy?

### One of the liberal arts

In any case, if science were seen and taught in such a light, we would not see the presidents of great universities (not scientists) going around the country saying, "There is too much emphasis on science; let us return to the liberal arts."

Science is one of the liberal arts—one of the first and greatest of them. It certainly is one of man's greatest arts and is one which has done the most to *liberate* the human spirit. Science, more than any other subject, has freed men from ignorance and from consequent fear. Consequently, it has elevated man, intellectually and spiritually.

How does it happen that many people have just the opposite conception — that science has been degrading to man; has made him materialistic, unmoral? Apparently it is because scientists are wholly misunderstood.

For example, a distinguished religious leader recently said, "Modern technologists and scientists have come to regard themselves as supreme masters of the universe." Well! That's news to me. Does anyone here think *he* is the supreme master of the universe? Some of you might have good ideas about some improvements you would make if you were! But the only men in recent times who have thought themselves masters of the universe (Hitler, Mussolini, Stalin) were certainly not scientists! Science is a pursuit that makes men humble — because in learning a few things we come upon so many that we don't know.

But why do these misconceptions of scientists exist?

Personally, I put part of the blame for this on certain misguided philosophers. For example, since the instruments of the scientists have discovered no nonmaterial or nonphysical aspects of the world, therefore the scientist is accused of saying that such immaterial things do not exist. Because the anatomist found no place in the body to house a soul, therefore, says the philosopher, this proves man has no soul! That's nonsense, of course. Physical instruments were never intended to measure nonphysical things and, by their nature, they can never do so. Science thus gives no support to materialism — nor, of course, can it ever disprove it either. Philosophical theories are just not susceptible to experimental proof or disproof.

### Misunderstanding and misrepresentation

Again — philosophers have gone wild speculating about the theory of relativity and its philosophical implications. Now the special theory of relativity is simply a theory in physics which describes how the results of observations made on various phenomena will depend on how the observer is moving relative to what he observes. "Aha!" says the philosopher, "that means everything is relative; nothing is absolute. There are no absolutes physically; therefore there are none intellectually or morally either. It all depends on your point of view."

Nonsense again. Aside from the fact that physical theories have no necessary relevance to moral problems, the philosopher totally misunderstands Einstein's relativity theory. Though the relativity theory did show that many observed quantities were changed when there was relative motion (as had always been known), Einstein found that certain things (the velocity of light, for example) were unchanged. They were "relativistically invariant"; they were "absolutes."

A beautiful physical theory thus has been misunderstood and misused; again science has been misrepresented.

Then, too, there were philosophers who said that the theory of evolution denied the existence of God! No scientific theory can either affirm or deny a spiritual existence, of course. But, even so, why does anyone think it is degrading to have God create man by the beautiful processes of organic evolution rather than by making him out of a piece of clay? Especially when He then made Eve by the process of swiping one of Adam's ribs!

To me the whole picture of the universe as revealed by science, as well as the picture of the processes that go on within it and of the life that inhabits it, is one of magnificence, vastness, order, splendor, precision, beauty. It is a picture that exalts the Creator of the Universe — and exalts the dignity of the men He created, the men who can discover and comprehend this majesty of creation.

You see, perhaps, why I can claim that science is

one of the "liberalizing arts." You see why it deserves a place of respect along with the humanities, the fine arts and social and behavioral studies as partners and coequals in the intellectual and cultural fields. You see why to dismiss science as too "technical" and too "vocational" is both false and revolting.

However, there are men who say science is still not enough. Of course it isn't! And I do not know any scientist who ever claimed it was. The study of the physical world is *one* important aspect of man's use of his intelligence and his talents. It is one expression of the urge to know, to create. But the studies of the world of human beings, of the world of beauty and the world of moral values are equally essential activities — all are necessary to the educated and civilized man.

### "Science is not enough"

Some of those who say science is not enough, however, mean more than that. They mean to reduce science, to eliminate it, to cast it out of a liberal education, to put it in the same class with manual training and shop work. Because science is useful it is dismissed as "mere vocationalism." Because it is exact it is said to be "too technical." There has been created a cult of antisience — a group of superior beings who read only old books, look only at old pictures, think only old thoughts. They disdain the crass technicalities of algebra, the boring regularities of Newton's laws, the smelly products of chemistry. (However, at the first opportunity they don their nylon shirts and hose and take a Super-Constellation to Paris!)

And why do these antisientists get so wide a hearing? There are many complex reasons — but partly it is our own fault — the fault of scientists. We have, in times past, not distinguished between the problem of training an automobile mechanic and of educating a mechanical engineer. As late as 20 years ago there were so-called engineering colleges which trained only the hands and not the mind. There were also schools which had eliminated all educational opportunities except in the scientific and technical fields.

But I know of no such colleges today. The best modern institutes of technology offer superb programs in humanities and social studies — and they insist that the students take them. Overspecialized scientists or engineers are no longer being graduated in any numbers from the American system of higher education — and the number who graduated in the past was not so large as many people pretend. Most of the scientists and engineers that I know — of any age — are well-educated, well-rounded people; many are persons of very extraordinary culture and cultivation. Of course, I also know a few characters who can talk of nothing but their specialty. But I know similar people who are lawyers, doctors, business men and English professors too.

Every now and then even the proponents of the liberal arts realize that some of their members have gone too far and claimed too much. Listen to this wonderful

statement by Lynn White, Jr., President of Mills College:

"Spokesmen for the colleges (including me) are constantly trumpeting the importance of the liberal arts as inculcating resourcefulness, spontaneity of spirit, the ability to meet unexpected situations, and that sort of thing. In its extreme form this sound metal contains a certain alloy of nonsense. The Mid-Victorian view that reading Horace at Oxford prepared one to be proconsul over steaming tropical millions overlooked the fact that Oxford in its great days was deftly designed to convince its aristocratic denizens that they were God's anointed, predestined to shepherd and shear the less elect portions of the human race. Such massive self-confidence, even when occasionally coupled with stupidity and inefficiency, was irresistible on the banks of the great, gray-green, greasy Limpopo and one may doubt whether the Latin poets had much to do with the diffusion of the Union Jack."

I think it is important then that we think of pure science as a dignifying and edifying — as well as a useful — area of human learning. Possibly then when we come to think of applied science we will think and speak not only of the useful gadgets that we produce, but of the goals of human comfort, leisure, culture and happiness they help us achieve.

Perhaps, however, the most damaging blows struck by the antisientists are those which prey upon the fears and dangers of the modern world which applied science has helped to build. These dangers are indeed real and terrifying. And scientists will do well to continue making factual statements about what these dangers are. Thermonuclear bombs are really horribly devastating weapons — and don't let anyone tell you otherwise.

### Freedom from danger

But the real basis for our fears today is not the human ingenuity that produced terrible weapons, but the human cussedness that threatens to use such weapons against us. The world has never been free from danger. But if we contrast the western world of today with that of 100 years ago, we find much to be proud of. We have eliminated slavery — because our work is now done for us by lumps of coal and pools of oil. We have eliminated much of human suffering caused by ailments and disease — and we will no longer tolerate the existence of suffering caused by human cruelty or neglect.

We have eliminated many evils and many dangers; we face many more of both old and new varieties. But we shall conquer danger not by weeping and wailing, not by stopping or impeding any worthwhile human endeavor, by belittling any noble human aspiration. We shall conquer fear in the end only if we continue to explore the unknown in every field of human endeavor, continue to extend always the frontiers of knowledge, aiming always to elevate the human mind and the human spirit.