

SCIENCE: A LIBERATING ART

by L. A. DuBridge

As an undergraduate at Cornell College — all of 40 years ago — it did not seem strange to me that I was going to a liberal arts college to major in a science. Quite a few of us were doing it and, as far as I can recall, we were regarded as no different from the students majoring in English or economics, or music or philosophy. We used to kid each other on our strange tastes, of course. But it was only many years later that I began to read about how some people believed that the scientists lived in one world and the liberal arts majors in another one. And then, just a few years ago, I began to hear some people suggesting that the world of science was an evil, materialistic, inhuman sort of world, and that only in the liberal arts did men think beautiful thoughts and have generous impulses and learn how to get along with other people.

Well, all this was news to me. And it still is! I have always thought the sciences were a part of the liberal arts; that the natural sciences, the social studies, the humanities, and the fine arts were all included in the term “liberal arts”—and that each of these fields was an essential part of our culture, and of a liberal education.

When the human mind is seeking to learn, it doesn't make much difference what subject is being examined at the moment. The same attitudes of open-mindedness, of curiosity, of thoughtfulness, of concentration, are necessary whether we seek to understand history or philosophy or physics. We must learn a different vocabulary to master each of these fields, of course—for each subject must have names for its ideas, its concepts, for the facts and phenomena with which it deals. The musician talks of counterpoint, the physicist of quantum theory, the philosopher of empiricism, the poet of hexameters, the geologist of seismicity — and the student must, sooner or later, learn what these words mean, what ideas or concepts or things they represent.

It is perfectly true that, as one delves further and further into any subject, the number of new words and phrases he must use becomes very great, for he is dealing with more and more ideas, more complex re-

lationships, more varied phenomena. That's what knowledge is — the mastery of new ideas. When two musicians, for example, get into a detailed discussion of their subject, their conversation is wholly incomprehensible to anyone who is not a musical scholar. The same is true for two philosophers, economists, or literary scholars — just as much as it is for biologists or chemists or physicists. The language barriers between different scholarly fields are truly imposing and they get more and more insurmountable the more knowledge grows, and the more special branches develop. It has been suggested that eventually this proliferation of scholarly specialties will result in every scholar having his own little field of knowledge about which he can converse with no one but himself. That's a gross exaggeration, of course; scholars are much too talkative and too gregarious to ever allow themselves to get into that situation. There will always be at least *two* in each field!

Language barriers are terrible things, whether they bar communications between nations, or between scholarly disciplines.

However, the language barrier is not peculiar to the relation between science and non-science. The artist and the musician have vocabularies just as different from each other as they are from those of the biologist, the physicist, the chemist, or the economist. Language problems pervade the whole field of knowledge — in all subjects — so let's not let anybody persuade us that language barriers provide the excuse for driving a wedge just between the sciences and the humanities, or that a gulf exists there which is not to be found elsewhere. The gulf is everywhere and constitutes the challenging problem of the world of the scholar — of the whole world of the intellect. And that means for the whole world itself.

But it is not a hopeless problem. Highly specialized scholars in any field will always have their special language. They must have it, or else they cannot talk or think in precise terms about their subject. Though it is regrettable when groups of specialized scholars get isolated from each other, it constitutes no danger of great or imminent calamity.

But there is another danger that does exist. If not just small special fields, but whole broad areas of knowledge, become isolated from each other and thus become isolated from the everyday world of men — then we could be in trouble.

We see a dramatic example of this sort of thing in the Soviet Union today. There, not by the will of the scholars or teachers, but by force of the state, the young student, and the adult, too, lives in a frightening condition of intellectual isolation. He is not allowed to learn anything like a history of the western world. He can have no contact with modern economic thought except that which follows a particular line. Social studies, current affairs, and much of western literature are closed books in his educational career and in his daily reading. It is frightening that such a situation can exist. It is unbelievable that in these days of rapid communications and transportation it can persist. Yet there it is—a vast nation in ignorance; and, in its ignorance, following an unscrupulous group of leaders who may well lead the civilized world to the brink of destruction.

We are fortunate that in this country we need not submit to enforced ignorance. But that does not mean that ignorance does not exist. Far from it. We may have self-imposed ignorance, ignorance which we drift into through laziness, or neglect, or misunderstanding.

Our bulwark against serious doses of such “ignorance by neglect” is our free educational system. From kindergarten through the PhD, and even beyond, an American boy or girl can now proceed as far as his talents will take him. Opportunities are not yet fully equalized, we must admit. Geographical, racial, and other inequities still exist. But, by and large, we have an educational system open to all subjects and to all students on a scale undreamed of in any other age — and even today in any other country.

Surely we are immune from widespread ignorance.

But are we?

Are our high school and college graduates really getting a worthy education? Are they emerging from school with a comprehension of the basic ideas and the basic language of each field of knowledge — of literature, history, social studies, physical, and biological sciences?

Is it possible that many high school graduates are closed off from further learning because they can't really read — or because they haven't really learned to *want* to read?

Have the vistas of history, the history of men and of ideas, been opened up to students in their school years? Or have such vistas been forever sealed off from them because they think history means only memorizing the dates of wars and the names of kings?

Are the great ideas of science forever closed because mathematics was too hard and too dull, chemistry too smelly, and biology too messy?

I am not trying to condemn our whole educational system. I abhor such sweeping indictments. And I

can say at once that the answers to these questions I have been raising are, in many places and for many people, wholly favorable. Our young people who are brightest and who are going to our best schools and colleges are receiving a superb education. And it is getting better every year.

But we have a long way to go. The thirst for knowledge is not really very widespread. The ability to follow the meaning of current national and world affairs is not really possessed by many people.

We have had a serious jolt in the past dozen years. Because of many events that have transpired through advances in science and technology — atomic weapons, automation, and space exploration, to name but three — we have suddenly become aware of the fact that, as a nation, we are vastly illiterate in scientific fields. The Sputnik events rammed this lesson down our throats — but it was evident long before 1957. It is not just that people did not know about nuclear fission and radioactivity; about electronic computers and transistors; about gravity and the moon and planets and stars. The trouble was that they had no basis on which to begin to learn about them. The language was utterly strange. The simplest ideas of force, energy, radiation, and gravitation were quite unfamiliar. People always thought such technical things were too difficult, and of no importance anyway.

Suddenly, we found that the whole world was unexpectedly being changed by these “unimportant” technical ideas. Suddenly congressmen were voting billions of dollars for atomic energy, when they and their constituents often had no idea what the words meant. They then voted more billions for space exploration, with no possibility of knowing why we are going there, or what we intend to do, except that somehow they feel we must “keep ahead of the Russians.”

So, indeed, we found that in one huge area of human knowledge millions of Americans were just as ignorant as though the study of science had been forbidden in our schools. “Ignorance by neglect” had grown upon us in a big way—and without our being aware of it.

It is no accident that this ignorance grew up during the period between the world wars when many voices were loudly proclaiming that there was too much emphasis on science, that technical subjects had no place in a liberal arts curriculum, and that trigonometry and physics were much too difficult subjects to inflict on high school students. Not every school and not every college believed such nonsense.

But still ignorance grew to such an extent that, by 1940, scientific illiteracy was a very widespread disease. And it has been a costly disease indeed, as we can see from the public confusion and misunderstandings which have arisen since World War II.

First came the era of secrecy and suspicion. The United States had invented some miraculous new war

weapons — radar, proximity fuses, sonar, and atomic bombs. If any other nation now showed up with any of these devices, it was at once concluded either (a) that foreign spies had stolen the secrets from us, or (b) that American traitors had given the secrets away. Charges and countercharges were hurled; every scientist who had engaged in war work was investigated — not to determine whether he had done a good job, but to determine whether he or his wife, or his family, had any “questionable” friends. And who was a questionable friend? Well, he was someone who, in turn, had a questionable friend. There was no limit to suspicions — and hence to fear. And the healthy development of science was seriously impaired.

All this happened because too few people understood the nature of science. Too few understood that it was often true that scientists in different parts of the world, interested in similar problems, came upon identical solutions; that the only true secrets involved were secrets of nature, secrets which nature gladly gave up to any inquiring mind, regardless of race, creed, color, or nationality.

Then, years later, came the hysteria engendered by Sputnik. The Russians, it seems, decided to develop and make (for reasons best known to themselves) an 800,000-pound-thrust rocket. The Americans, for perfectly sound military and economic reasons, decided a 350,000-pound thrust was what we needed. Suddenly the Russians decided to use one of their big military rockets to orbit a satellite. We in the United States were giving our attention to making more useful military weapons.

If the Russians purposely launched Sputnik to persuade us to stop making military weapons, they almost succeeded. The clamor for bigger rockets to get bigger loads into space was deafening. What were the loads to *do* in space? “Never mind, just *get* there — at any cost!” “Why can’t we do it faster?” “Obviously, our scientists must be incompetent” — though it is engineers, *not* scientists, who make rockets. “If our scientists are incompetent, our schools must be no good.”

And so the hullabaloo mounted — and it hasn’t abated yet. “We must get a man into orbit; we must get a man to the moon.” Why? Just to beat the Russians?

Well, no scientist gives that answer. The scientist goes into space to conduct scientific research. And that’s all! He would like to get his instruments to the moon first, of course. But he knows that no great calamity will befall if the Russians find out whether there is any magnesium carbonate on the moon before we do.

So we have the complete paradox. Our confusion about space is not because the scientists are incompetent; they are busily engaged in all sorts of valuable space research enterprises. It’s not because the engineers are incompetent; they built the kind of rockets which the United States clearly needed. And,

in 1956, you could find hardly anyone in the United States who felt that our most urgent need was for an earth satellite. And the scientists, engineers, and military people were right. We didn’t need such a satellite for any urgent scientific, engineering, or military purposes. The only people who were negligent were the propaganda experts. Why didn’t *they* say we needed a satellite for propaganda purposes?

Probably because they had never studied any science and didn’t know what an earth satellite was — or that it was possible.

And why did Sputnik have such an enormous propaganda impact?

Because, to a nation — indeed, to a world — illiterate in science, its significance was grossly exaggerated and misinterpreted. And people naturally concluded that a nation that could make such a miraculous device — something they had never *heard* of — must be a nation of supermen.

Illiteracy, ignorance by neglect, can lead to strange things — sometimes to frightening things.

Fortunately, a democracy often muddles through. Space science is on a more sensible basis now, though still suffering from unduly large propaganda overtones. The military have returned to working on military weapons — almost.

And our schools? Well, even though they had nothing whatever to do with Sputnik, we are now busily improving our schools anyway. For whatever reason, *that* at least is a good thing.

And the results are beginning to show. Our freshmen at Caltech now turn up with high school credits not only in trigonometry, but even (about 40 percent of them) in calculus. Our freshman chemistry course went out of date several years ago; the present one is more like what our sophomore and junior courses *combined* were like then. A similar situation exists in physics, and also, praise be, in English.

Our freshmen are very highly selected, of course. But a change in the schools has come, and it is spreading.

Liberal arts courses in college, I predict, will also soon return to a balance between all of the liberal arts — not just the non-scientific ones.

But I would be missing the most important reason why I think this is good if I left the impression that the only function of teaching science to everyone is to help people understand the technical basis of modern society — the technical facts of industry, transportation, communication, and of modern war.

There is much more to it. Science is one of the truly *liberating* arts. It frees the mind of ignorance of the world we live in. It expands our horizons, letting us see man in his true perspective in a colossal universe. It helps men understand the nature of learning, the process of attaining understanding. And, as one appreciates the process by which men’s minds acquire understanding, one better appreciates men’s minds — and better appreciates *men*.