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THE SHAPE OF THE FUTURE

"Science deals only with things—not people."

But does it?

Some reflections on science, scientists, and the future.

by L. A. DuBridge

The fact that social and natural scientists seem to have little to say to each other is one of the tragedies of modern times. What is it that causes this gulf between the two worlds?

Many people will give you a pat answer. "Science," they say, "deals with *things;* social science deals with *people.*"

Well, aside from the fact that people and things have much in common (they are both composed of the same *atoms,* for example), the statement is simply not true. Does science deal only with things? Scientists study atoms and molecules; they study the earth, the planets, and the stars; they study about forces and energy and radiation; about genes and viruses and bacteria and cells. All *"things,"* you say. And so, in a sense, they are.

But there are two questions to ask: (1) Why do they study these particular things? and (2) How do they study them?

The answer to the first is easy: they choose things to study that *people* are interested in. That's silly, you may say; people aren't interested in atoms and crystals and stars and cells. Aren't they? Oh, yes, they are. And they'd better be. People have to inhabit this world – this universe. They are also *made* of atoms and molecules and cells. Everything they touch and handle is composed of the things the scientist studies. We are what we are because of the nature of the world in which we live.

Every act we perform, every thought we think, the very nature and structure of our bodies and minds themselves have been conditioned by the thousands of millions of years during which living beings have evolved on this particular planet. And eventually men became men – not because they were built of different molecules than other animals, but because man was equipped with a brain which could understand the physical world in which he lived, and, *understanding it, could adapt himself more perfectly* to it. And now men are on the verge of a better understanding of their own brains.

Man is a man because he observes, thinks, tries to understand things, and tries to make things useful. Man is a man, in short, because he is a scientist – because he studies the things that interest him and that may be useful to him, or may at least satisfy his curiosity.

Does science, then, have nothing to do with people? No – rather, science *is* people, people *thinking.*

How do scientists work? Well, they work like people too. They have curiosity; they try to satisfy it. They make mistakes, terrible mistakes. But they then discover their errors and try to correct them. They learn many things, and then they invent theories or laws or principles to correlate or explain their findings. They quarrel with each other about who is right or who is wrong about the theories of gravitation, or of atoms, of cosmology, heredity, disease,

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or bodily functions. Human brains struggle mightily, trying to understand – and since they are human brains, their struggles to learn and to understand are limited by human prejudices, human experience, human failings. But they struggle on because they also have intense human aspirations, yearnings, and ideals.

The presumption that a scientist deals solely with a group of objective facts which he discovers about the physical universe is only part of the story. He must correlate and understand those facts, and he must also select from all the possible facts the particular ones that are of interest to him. These are truly creative processes; so his human interests, failings, limitations, desires, and capacities are a controlling element in his creative achievements. But also controlling are his human senses of beauty and order; his human instinct to know and to understand; his faith that the world can be understood.

Science—an intensely human undertaking

Science is an intensely human undertaking, involving not only the personal qualities of individual scientists, but a vast amount of communication, cooperation, and even conflict, between scientists. Scientists are people; they work and live and often fight as people. And they enjoy the human capacities and suffer from human frailties just like other people. Science is, in short, a social activity – and in a modern society it is a very important social activity.

Is social science, by contrast, exclusively a study of people? Granted that its objective is to understand how people behave, it must clearly take into account the fact that human activities, human living, and human relations are enormously affected by what human beings *are* and what they *know*. And what they know about the physical world and about themselves, and how they use this knowledge, is determined by the progress of science and technology.

Can anyone pretend that sociology, economics, philosophy, psychology, literature, history, or any other field of the humanities or social science has been unaffected by advances in scientific knowledge? Quite the contrary, our whole civilization, our whole social and economic system, our culture itself, is conditioned by such knowledge. Has not our whole social environment been radically altered by the telephone, the automobile, by radio and television? Has not the whole political environment been revolutionized by nuclear fission and fusion?

It may be said that none of these things has changed human nature itself. Men still write poetry and plays, love their wives and families, quarrel with neighbors over the back fence, brag about their own grandchildren and criticize everyone else's – just as they have always done. But the family arguments today often center around who gets to use the car, or which TV program we shall watch.

All our activities are affected by technology.

An international crisis arises and the world's statesmen are instantly on the phone, and the next day are meeting personally in New York, London, Geneva, or Berlin.

Oldtime educators wring their hands because colleges no longer teach Latin and Greek – to students who want to learn about electronics and space.

A thirty years' war is now unthinkable – and we wonder if the next war will last thirty minutes!

A major battle of the War of 1812 was fought weeks after the peace treaty had been signed, but before the news of the war's ending had crossed the Atlantic.

The point is obvious: the social scientist who believes that science and technology have no bearing upon human beings is as obsolete as the dodo.

Conversely, the scientist or engineer who is unconcerned with the social implications of new discoveries and new inventions is equally obsolete.

That last statement may surprise you, for it is a common aphorism that scientists and engineers carelessly toss out their discoveries to a waiting, or unsuspecting, or even unwilling world with no thought of what the consequences may be.

Discoveries and consequences

There is some truth in this. When a wholly new discovery in basic science is made, the scientist can't possibly ask himself what the social consequences of his discovery will be before he makes it. No one knows whether, or when, he is going to turn up a new idea or a new fact. Nor can he have any idea what it will be and, still less, whether it may have any applications, useful or precarious. Even after he makes his discovery, its applications are usually wholly unknown or obscure. The men who created the theory known as quantum mechanics could not have dreamed that this would lead to a revolution in the chemical industry, to a whole new era in transistor electronics, to computer machines that stagger the imagination with their speed and potentialities – much less to an understanding of atomic nuclei which led directly to practical attainment of nuclear energy devices.

Similarly, Einstein, back in 1905, could not possibly have foreseen the consequences of his relativity theory, either in an enlarged understanding of the universe or in the creation of atomic bombs. Nor could any one of the other thousands of physicists, mathematicians, chemists, biologists, or geologists who in the past one hundred years have contributed to a vastly increased understanding of the physical world have anticipated how his discovery could have contributed – along with others not yet made – to any discernible impact on society as a whole.

The engineer or applied scientist may be in a slight-

ly different position. He is seeking to use existing scientific knowledge to develop devices which will be useful to people or to society. In general, he concentrates on those matters which he believes, or his company believes, will be of human value – and which will thus find a large market. Surely, then, the engineer or inventor owes it to society to reflect on how his new creation will affect the society which uses it.

The engineer often does. In fact, I think one can say today that he *usually* does. The engineer directing a research project in industry normally believes sincerely, and usually correctly, that his project – be it better automobiles or telephones, or television sets, or airplanes or washing machines, or electronic computers – will benefit humanity at large. And he takes pride in contributing to such benefits. That's why he is an engineer rather than something else. He is concerned about the social impact of his work; and he wants the result to be good, not bad.

Unforeseeable consequences

No matter how much he tries, however, the inventor cannot foresee *all* the social consequences of his products. Henry Ford deeply believed that cheap family transportation would enormously benefit most Americans. And so it did. But could he have anticipated that he would change radically the pattern of metropolitan living, that his automobiles would eventually so jam our city streets that it would be faster to return to walking? Could he have foreseen the development of a whole new industry to manufacture gasoline and oil for his gas-buggies, another industry to make steel, yet another to make rubber for tires, and still another to build the roads and highways that millions of cars would need? Could he have foreseen that someday a labor stoppage in Detroit could nearly paralyze the economy?

Neither Henry Ford nor anyone else could have foreseen all this. And even if he had, what would he have done – destroyed his invention, only to let someone else make all that money? And who is to say whether the net result has been good or bad?

But I have been giving only examples of so-called peaceful inventions – things that looked (at first, at least) as though they would *benefit* people, not kill them. Of course, the automobile has killed more people than most of the wars between nations ever did, but that's an unforeseeable consequence too.

How about those who purposefully and energetically set out to make new weapons of war. Couldn't they have a little more consideration for human life and human welfare and international relations? Shouldn't the scientists, for example, have refused to make an atomic bomb? Should they now refuse to make other new weapons?

The answer to that is fairly easy. The men who made the atomic bomb were not sadists. I know many of them very well. They are men who knew in 1942 that America was in grave peril – and so were all the ideals which Americans had always fostered and cherished. They would have been less than human, certainly less than patriotic, if they had not been both willing and anxious to contribute to America's defense. Many of them knew the potential consequences of the Bomb – and feared them. But they feared even more the consequences of defeat by the Axis powers. And today they fear still more the consequences of defeat by Soviet Russia. Either defeat could have meant the death of freedom. And if freedom must be protected by force, it is essential that the forces available to free nations be adequate for the task.

While scientists and engineers work to keep America's defenses adequate, they also in great numbers and with great energy try to persuade the peoples of the world that war is obsolete, that these weapons should never be used, that peaceful ways to solve international disputes must be found.

Unforeseeable benefits

Their success in this endeavor has, as yet, not been too startling. And the scientists have set off some pretty bitter controversies in their efforts. But such efforts must be made, and in a new era of human relations, controversies on method are bound to occur. All the more reason for all men of good will to join together and devote their best efforts to this task. In some ways, atomic weapons have brought scientists, social scientists, businessmen, and politicians closer together than any other technical development in history. Maybe this is its most important consequence – an unforeseeable benefit.

My point, then, is this: Scientists and engineers do worry about the consequences of their work. But neither they nor anyone else has discovered how to avoid or even to predict these consequences.

So far I have been speaking of the past. What of the future? I should love to tell you all about the scientific discoveries that are about to be made and

how they will be used, and what the social consequences of each will be. That is manifestly impossible for anyone. Yet some things can be said. Some new and important developments of great potential import have already taken place. Maybe scientists and social scientists would do well to ponder on some of the things already in sight.

What is in sight?

Automation—and problems

First, human manual labor – and indeed most routine nonthinking operations by humans – are soon to be obsolete. Oh yes, the housewife must still sweep the floors and scrub the children, men and women must still water the flowers and mow the lawn (with a power mower, of course). Houses must be painted, fields plowed, trucks driven, and so on.

But industrial processes, processes involving mass production, are more and more going to be carried on by machines, and the machines are going to be controlled by electronic devices. "Automation" many call it – a nasty word in many circles. But it's here and it's spreading fast. And when automatic machines can manufacture goods faster, cheaper, and better than by hand, they can't be stopped. In fact, they should be welcomed with loud cheers. Alleviation of hard labor is one of the most cherished dreams of mankind.

But there are problems. Men trained to perform only a certain kind of manual operation will face unemployment. How shall we cope with this? By preventing automation? Or by subsidizing the unemployed? Or by retraining them to do other jobs? By moving them to other locations? Or what?

Here is a prime example of the social consequences, just emerging, of a new technological development. I commend it to you for study. But don't confine the study to berating the technological development. Rather, let's first understand it, evaluate its values and its dangers, examine the human and economic problems that may evolve, perform limited experiments to learn the possibilities and problems of retraining, redeployment, or relief. And also ask the question whether, in the nation as a whole, the long-time benefits will be great or small, and to what extent they justify strenuous and expensive measures to avoid any inevitable human suffering.

We have entered the space age. During the next 10 or 20 years – probably for the next 100 or 1000 years – we are going to be spending several billion dollars a year to send instruments and men into space, to land on the moon and later, on the nearby planets, Venus and Mars. Still later, we shall go to the far reaches of the solar system.

What social consequences will result? Only a very few are clearly discernible. We shall spend a lot of money and we shall create whole new industries. Will this stimulate economic prosperity, or will it destroy it by higher taxes? You will hear opinions on both sides. Is it possible to learn the truth?

Will the space results be worth the cost? Who can tell? Who can evaluate in dollars the worth of new knowledge, the value of human exploration, the importance of satisfying man's eternal yearning to break the chains that tie him to the surface of this planet and let him see what other worlds are like? And who can place a dollar value on keeping ahead of the Russians?

Will great new military power result from space exploits? Personally I think not, but I could be wrong. Will new materials be discovered on the moon or on Mars that will revolutionize life on earth? Again, the chances are vastly against it, but we can't be sure till we get there. Can the moon or Mars or another planet be used to establish colonies to siphon off the earth's excess population? As of now, the answer is assuredly *no*. Other planets are all but totally uninhabitable by human beings, and shipping off thirty million people a year in giant rockets seems unlikely to be a practical undertaking very soon.

What, then, does space exploration mean? Right now it means loads of money spent to attain new knowledge. How it will affect the way people live and act we can't yet imagine.

I commend the problem to you for study. However, please don't let the conclusion to your study be simply the statement that space is no damn good. Men are going there; they can't be stopped. The question is: How do we make the going yield the greatest benefits and the fewest sorrows?

Also, do not let the conclusion of your study be simply that the billions spent on space could be better expended in building roads or curing cancer, or studying the atom, or improving the social or behavioral sciences. If the space program stopped, that money would not suddenly be given to the New School, or to Columbia University, or to Caltech. That money is being appropriated for something that most people (or at least most congressmen) believe is important. It is not automatically transferable to other items. Those other items must be presented to Congress on their own merits. A ten-billion-dollar appropriation for cancer would not result in a sure cure. We don't know enough to spend it. We *do* know enough to get into space. For better or worse, we have to concentrate on those things we know how to do.

A package of problems

The final problem I am going to suggest is really a package of problems. It is this: From a purely technical standpoint, we now know enough to do each of the following things—

1. Produce enough food to feed every hungry mouth on earth, and to do this even though the population should double or treble.

2. Make fresh water out of sea water and thus irrigate all the world's arid regions.

3. Revolutionize the transportation system in our cities, eliminating traffic jams and allowing everyone to go to and from his work with speed and comfort.

4. Transport large numbers of people or large quantities of material from any place on earth to any other in a few hours.

5. Produce enough energy from uranium to light and heat our homes and offices, electrify our railroads, and run all our factories and mills.

6. Build automobiles, washing machines, houses, buildings, and a myriad of other devices and structures which will last under hard use not one or two or five to ten years, but 10 or 50 or 100 or 500 years.

7. Establish instantaneous communication by telegraph, telephone, teletype, or television between any two points on the face of the earth – and indeed, when the occasion arises, between any two points of the solar system.

8. Rid the air of our cities of all forms of man-made pollution.

9. Build houses, buildings, and whole cities which are essentially weatherproof – heat-proof, cold-proof, and storm-proof – and make every city as nice as California!

I assure you that all of these things, and many more I have not named – are technically feasible. A few, as you know, are now being done on a small scale. Why don't we do them all on a big scale, and thus solve a host of the world's problems?

There is just one small difficulty. Money!

A matter of money

Every one of these things I have mentioned, though now technically feasible, is far too costly to be undertaken except in limited circumstances, and some are too costly to be undertaken at all. It is true that further technical developments and discoveries may make some of them cheaper some day. But right now a host of techniques capable of solving mankind's problems and easing his burdens cannot be used because we do not know how to bring adequate resources of money, labor, and materials to bear on the problems – or bring them to bear in such a way that the results achieved would, in a monetary sense, justify the costs. There is no present hope that any one of the nine items I mentioned will be economically feasible.

It is technically feasible, for example, to irrigate all the western deserts in the United States with distilled sea water. But the cost would be so tremendous that the value of the extra food produced – even though it may be desperately needed, say, in India or Burma or Africa – would not begin to pay the annual operating costs. And this is true no matter whether private or public funds are used. This situation might change if the costs of rectified sea water go down or the price of food goes up. But, as of today, and apparently for many years to come, it is just not economically justified. The same is true of uranium energy, of rapid metropolitan transport, and all the rest.

Is there a solution to this economic dilemma? I don't know, and I'm afraid I don't even believe it can be solved by economic or social measures alone. Nor do I now see any technical solutions either. I may, however, be too pessimistic.

But I suggest it is a challenging problem.

Finally, let me point out only too briefly that all mankind is faced with one overpowering problem: *ignorance*. And I don't mean lack of education – although there is plenty of that too. I mean that men are just plain ignorant. No one knows how to make men live to be 150 years old; no one knows precisely what holds the atomic nucleus together; no one knows how big the universe is or how it evolved; no one knows how to persuade men to live together peaceably on the only planet we now have; no one knows how to stop crime, to run a democratic government more effectively, to avoid economic depressions, to eliminate unemployment, or to finance our schools and colleges adequately.

Why, we are so ignorant we don't even know all the things we don't know! Our island of knowledge in the vast sea of ignorance is so tiny we wonder whether it may not be wholly engulfed.

So what shall we do?

The fight against ignorance

First: Let's not be discouraged. This earth has existed four billion years and will probably last another four billion. Human beings began to learn how not to be so ignorant only a few thousand years ago. Maybe a few million years hence we may have learned quite a lot.

Second: Let's spend more effort on learning. We may be terribly ignorant, but we don't have to stay that way. We at least have learned how to learn – slowly and inadequately perhaps, but we have made progress. If only we took the learning process a little more seriously, we could learn even faster. Most of the people in the world don't want men to learn more, or don't think it is important.

But thousands or millions of men and women around the world do. And they are going to keep on encouraging and supporting the fight against mankind's ignorance because they know it is the most important thing on earth.

That is why thousands of centers of learning throughout the world exist. They are the essential outposts in this quest for more knowledge in all fields.

"Seek ye the truth – and the truth shall make you free."

No more important injunction was ever enunciated to the human race.