

*Science, Society, Action, Reaction*

The author of this editorial, who is known for his contributions to cosmology, especially the steady-state theory of the universe, is head of the Institute of Theoretical Astronomy at Cambridge University. The editorial is based on his recent speech before the Chicago joint meeting of the American Association of Physics Teachers and the American Physical Society.

We make a mistake, I believe, in thinking the rising cost and sophistication of physics is a smooth function of time. When we change the kind of physics we aim to study—more precisely, the coupling constants—we become involved in economic discontinuities. Problems controlled by the Rydberg are cheap. Problems of nuclear structure are still within the economic range that society will support. Problems of nucleon structure are so large that only a clearcut victory in physics-society relations will permit a resolution of the financial problem in favor of the physicist.

It may seem a little curious for an astronomer to write on such a sensitive domestic matter, but in a sense an astronomer is well qualified to do so. Traditionally astronomy has been expensive. Telescopes were costing millions when physicists were still in the string-and-sealing-wax era.

I emphasize these points because I think high-energy physicists have made errors in presenting to society their case for the next round of machines. They have encouraged the concept that physics requires an exponentially rising expenditure. No sensible treasury could accept such a proposition. Treasury men understand the properties of the exponential function as well as we do.

My point is this: Not only is it bad tactics to give the impression that our requests are open ended, but it is not true. Given energies in the center-of-mass system appreciably larger than the proton rest mass, it should be possible to solve the problems now in the center of the particle-physics stage. High-energy physics

has moved onto a plateau where rest mass is the unit of energy, and the jump to this plateau produces the increase of cost. Other plateaus may open before us, but psychologically it is preferable to argue further leaps when the necessity arises.

Of course what applies to high-energy physics and its relation to society applies also to other branches of physics and indeed to science as a whole. Many examples show that science is indivisible. Speaking as an astronomer I am in a good position to say that we shall get nowhere by envying one another. And, whether we like it or not, science has become so strongly coupled to society that there is inevitable feedback on us.

I have spoken so far about physics, rather than about society, because I am sure that the root of the matter lies in ourselves, in understanding our own aims and ideals. I want to ask next whether the relation of the scientist to society that we have fallen into over the past two decades is really representative of the way we feel about the business.

Why in fact do we do physics? For financial reward, . . . a soft time, . . . heartfelt thanks? I hope none of this moves you deeply. If I wanted financial reward or prestige, I think there are simpler and more direct ways of going about it. Like pro football, it is a hard way to earn easy money. Richard Feynman was closer to the truth, I think, when he said, "If anything was more fun, I'd be doing it."

The real motive, of course, is a religious one. If this statement comes as a surprise to you, the reason is that nowadays our idea of religion has be-



come cheapened by meaningless repetition of concepts we know to be wrong. But in their day these concepts represented a view of the world that is the counterpart of modern physics. There was nothing contemptible about them, and the men who arrived at them were possibly not too different from us. Our aim is the same: to understand the world and ourselves, not to make a profit or justify ourselves by producing an endless stream of technical gadgets.

If you are with me on this point, I can continue by asking whether justifying ourselves with gadgets is really the way we should look on our relation with society. I think the policy is unsatisfactory because it is basically dishonest; we are not what we pretend to be; we are not in business as widget manufacturers.

It may well be said that to take a stand on an insubstantial point of view would be useless, and that the best hope for science is to string society along on a utility basis. But this procedure is not working well at the moment. It seems to me that our only chance for the future is to recognize ourselves for what we are—the priests of a not very popular religion—and to see what we can do about it. If society will not accept us for what we are, we must change society.

In this problem of the relation between science and society, there is no difficulty in the reading of history. The more civilized—in material terms—a society becomes, the more the people live out of contact with the natural world. We as physicists, interested above all in the natural world, can not

expect a society that has retreated from it to feel our excitement about our aims. In a barbaric society the situation would be different. The man who tills the soil is immediately interested to know what a clod of earth is made of. The hunter is interested in how the land forms came about. Offer this information to the man who drives to an office every morning along crowded freeways, and you get absolutely nowhere.

Of course you will say that civilization has produced important contributions. Very well—excluding modern times, what? There have been major discoveries, of which the most important, perhaps, was writing. Writing developed because of the need of rich corporations and royal treasuries to keep records of possessions. The discovery emerged, not out of curiosity and wonderment about the world, but essentially out of greed. And this, I believe, sums up our dilemma today. The scientist wishes to investigate the world out of a sense of wonderment whereas society is only moved to support such investigation through greed for useful devices. "Useful" in the popular terminology means things that lead to increased abstraction. "Use" consists quite largely in avoiding the movement of arms and legs. Being useful in the future may consist in permitting the majority of humans to spend all of their lives in an oxygen tent. Far from moving steadily toward a "Great Society," we are moving inexorably toward a trash society. The big issue is what, if anything, are we going to do about it?

Is it really true that we can do nothing about society, or are we

simply suffering from a kind of mental blockage? Isn't it really that in the past scientists just haven't dared to allow themselves to think openly of taking society by the scruff of the neck?

It appears to me that we have two courses open to us for the 1970's and 1980's. One is to continue as we are doing, accumulating as much knowledge as we can before the present civilization collapses. The alternative is to stop thinking of ourselves as the modern version of the tinker—which is the way the public and the politicians really see us—and to conceive that we might be capable of doing something about society. In the past, science acted on society through technology. Now society is reacting back on us. Do we amplify the cycle by intervening overtly? Or do we simply stand aside and allow things to go to the devil?

Thirty years ago it would have been meaningless to raise the question. We had no experience in large-scale organization. Nowadays this is no longer true. Experience gained in building and controlling large organizations for high-energy physics is already comparable with what is needed to control the economic structure of society.

My proposals for the 1970's are these: Either keep out of the mess or go right in and change it. Don't fall between; don't try faint-heartedly to change things and fail. Don't think that by merely being an adviser you will do any good at all. And, most important, realize that the changing of your own concepts may well be the hardest part of the job.

—Fred Hoyle