Letters

NAS Physics Report

In his editorial in the issue of 11 August (p. 479), Philip Abelson takes up the cudgels against the National Academy of Sciences report *Physics in Perspective* (*1*). This report, released on 15 August, is another in the series of NAS reviews of the status and needs of the different fields of science, carried out by a panel representing as wide a spectrum of specialties within that science as possible. Abelson accuses the report of being "self-serving"; indeed an attempt is made to present the merits of the discipline to those decision-makers who have to take not only those but also other values into account. Moreover, in this report, even more than in its predecessors, the authors analyze extensively the interaction of physics with the outside community, provide extensive data permitting others to dissect the science, and identify its internal problems and successes. I would like to see a report designed which would be less self-serving and still describe the status and opportunities of the field as thoroughly.

Abelson's principal target is high energy physics; yet here the "self-serving" argument clearly fails. Among the 17 original members of the Physics Survey Committee (two dropped out before the final report was issued), there were no high energy physics experimentalists. Only two theorists who have strong but by no means exclusive interests in elementary particle physics are on the panel, which is chaired by a low energy nuclear physicist. The Committee on Science and Public Policy of the National Academy of Sciences, which approved the report, contains no active high energy physicists.

Abelson concludes that "in a crunch high energy physics should defend itself on its own merits." Few would disagree, but what is merit? The authors of the report in question have been careful on this point; they have undertaken the thankless task of trying to assign rank orders for "merit" in the categories of "intrinsic merit," "extrinsic merit," and "structure." Extrinsic merit relates to current impact on other fields of science, on technology, and on the solution of human problems; intrinsic merit relates to the development of basic insights into nature, and from that to possible future application.

Not surprisingly, considering its fundamental nature, high energy physics is ranked very high indeed in the intrinsic merit category, but fairly low in extrinsic merit. This seems an eminently reasonable approach and certainly does not sustain Abelson's charge that "The committee seemed unable to be completely objective in its treatment of high energy physics." In fact, Abelson himself could be accused of lack of objectivity, as he focuses his criticism of high energy physics on only two narrow points: the currently visible impact of high energy physics on other areas of science and the totally unsupported charge that the training of high energy physicists has not equipped them to be creative in other fields. I had hoped that *Science* could take a broader view of the merit of a "science" than that.

Abelson states that it is regrettable that the "self-serving" nature of the report impairs its credibility, because "an excellent case could be made for maintaining the vitality of physics." I believe that the voluminous report *does* just that, but obviously any product can be improved; I would hope that Abelson could avail himself of the opportunity to make an even better case for maintaining the vitality of physics in a future issue of *Science*.

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Reference

1. D. A. Bromley, Ed., *Physics in Perspective* (Publ. No. 2037, National Academy of Sciences, Washington, D.C., 1972).

In his editorial on *Physics in Perspective*, Abelson questions the value of the pursuit of high energy physics because he believes it has only limited impact on physics, on science as a whole, and on society.

As practitioners of low energy physics, one of the disciplines whose impact. Abelson points out, has clearly been very great, we feel it important to present our reasons for disagreeing strongly with his evaluation. Although our research interest is in nuclear physics, we have had the opportunity to interact with the high energy program in several ways. We have served on the Physics Survey Committee, which produced the new physics report and we are serving as administrators in physics enterprises that include sizable groups of high energy physicists, as well as those devoted to other subfields.

High energy physics has had a great impact on all of physics through its essential participation in the discovery of universal laws. While the separate disciplines of physics, in important part, pursue their investigations separately of one another, the broad principles that are their real objectives must form a coherent synthesis across their borders. High energy physics probes the nature of the physical forces —the strong, the weak, and the electromagnetic interactions—which are basic to the structure of all matter. Thus the quantum electrodynamics tested in high energy experiments is the quantum electrodynamics first discovered in the atom. What nonsense it would have been for physicists interested in nuclear β-decay to have disregarded its connection to the τ-θ puzzle in particle physics. On the contrary, by putting the two together, the very general parity-nonconservation principle, important to all of physics and indeed to our understanding of the entire physical world, was discovered. No science can be pursued effectively if the investigation of one of its frontiers is expressly delimited. The frontiers of high energy physics are the frontiers of all physics.

If we may indulge in a homely analogy, in designing a building for rental income it would be unreasonable to expect much return from the lease of the foundation, but no income whatsoever would be assured if the building were without foundations. High energy physics is an essential part of the foundation. Moreover, it is quite wrong to write off the applications of high energy physics. We, as outsiders, already see the imminent development of a number of spin-offs of practical importance. But even more important than the technical spin-offs can be the wholly new applications of newly discovered principles such as have accompanied the development of each of the major domains of physics. The corresponding direct benefits of high energy physics are still to come in the future. It was a long time, after all, between the "nonrelevant" A and B coefficients of Einstein and "relevant" lasers, whose great practical importance Abelson notes.

Whatever the future will bring, it is abundantly clear that physics and all of science need high energy physics.

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Falling Watermelons

We live in mortal danger of being struck dead by watermelons inadvertently dropped from passing airplanes. Technology is obviously to blame for this hazard to life, because, if technologists had not developed airplanes, we would not have to worry about the danger of falling watermelons. However, when we examine the probability that a person will be struck by a falling watermelon, we must conclude that this environmental danger is not worth worrying about.

It is not easy to compute the probability of rare and unlikely events, such as death from eating mercury in tuna fish, cancers in human beings due to DDT ingestion, or the likelihood that PCB's (polychlorinated biphenyls) will have a deleterious effect on the environment (*1*). But many people prefer to conclude that new methods and new substances "may" be harmful and therefore should be banned until— if ever— they are proved innocuous.

The belief of Mosser *et al.* (Letters, 14 July, p. 119) "that the environmental impact of a chemical should be studied before it is released into the environment" is commendable in theory. More than a million products now result from man's activities (*2*). There are at least 2 million species of fauna and flora on the earth. Assuming that a team of biologists can assess the environmental impact of a man-made product on a species in 1 year's time, it would require some 2 trillion, biologist-person years to complete this worthy evaluation. The approach of Mosser *et al.* would solve the unemployment problem among biologists for some time to come, but the cost to society would be staggering. Jones W. Haun of General Mills, Inc., estimates that it costs his company approximately $75,000 for a 2-year program to merely prove the innocuousness to humans of *one* food additive (*3*). Long-term, low-level toxicity studies would cost many times more.

Mosser *et al.* assert that ". . . we have never subscribed to the theory that DDT (or PCB) usage could diminish the earth's oxygen supply." In a talk (*4*) given at Yale (1970), Wurster said of his laboratory studies on the effect of DDT on algae, "The data indicated that as DDT was added to water, the rate of photosynthesis was decreased. (Photosynthesis is the process whereby green plants absorb carbon dioxide and the energy from sunlight, producing organic nutrients and oxygen. All animal life on earth is dependent on this process.)" Wurster may never have believed that DDT could diminish the earth's oxygen supply, but his juxtaposition of sentences leaves the impression that this is the case. Paul Ehrlich elaborated on and disseminated the story of vanishing oxygen in the September 1969 issue of *Ramparts* (*5*).

Except for a few isolated instances when misuse of PCB's caused concern, the quantities of PCB entering the environment have been relatively minuscule, and the substance itself has a relatively low toxicity. The sole U.S. producer of PCB's has limited its use to sealed systems since the summer of 1971 (News and Comment, 3 Sept. 1971, p. 899). There is no evidence whatsoever that alteration of phytoplanktonic species by PCB's—if the effect is at all at work in nature—would have a deleterious effect on the environment. In the spectrum of realistic problems facing society today, PCB contamination hovers near the bottom of the list.

New ideas and new products are delicate things. One consequence of unrestrained precautionary study of possible environmental hazards of new ideas will be to kill most of them before they are born. No child, no idea is born into this world without the possibility of causing harm as it grows older. Shall we then abort all birth and all innovation for fear of possible environmental damage? That is what some environmentalists would have us do, but such a tack would lead society down the road to sterility.

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References

1. C. A. Adler, *Ecological Fantasies* (Arlington House, New Rochelle, N.Y., in press).
2. Study of Critical Environmental Problems, *Man's Impact on the Global Environment* (M.I.T. Press, Cambridge, Mass., 1970), p. 22.
3. *Report on Spring Meeting* (National Association of Manufacturers, Environmental Quality Committee, New York, 1972), p. 21.
4. H. E. Helfrich, *Agenda for Survival* (Yale Univ. Press, New Haven, Conn., 1971), p. 44.
5. P. Ehrlich, *Ramparts* **8**, 24 (1969).

DDT in Rainfall

The article by Woodwell, Craig, and Johnson (10 Dec. 1971, p. 1101) "What happens to DDT" has just permeated my environment. I wish to draw attention to an error in the figures quoted for the amount of DDT found in rain in England. In both of the papers cited (*1*), all results are given in parts per 10^{12}, not in parts per million.

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Reference

1. K. R. Tarrant and J. O. G. Tatton, *Nature* **219**, 725 (1968); G. A. Wheatley and J. A. Hardman, *ibid.* **207**, 486 (1965).

We are grateful that Hughes calls attention to a typographical error that might prove confusing. In the instance to which Hughes refers, ppm should have been ppt, which we used to indicate parts per 10^{12} parts. The text in the remaining segment of that paragraph and in the following paragraphs should, however, clarify that point for most readers.

We are indebted to Clare Stewart for pointing out a further typographical error in the formula in the section entitled "A model of DDT circulation in the biosphere." The N_i in the second summation should be N_j.

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