

Must We Always Be Gadgeteers?

As far as this writer can discover, the typical response of the physicist who wished to contribute to this latest international crisis has been to go to Los Alamos, or some other government laboratory for weapon development, for a summer or a year. No doubt this has been a valuable contribution to solving the present crisis and no doubt it has made the contributor feel he is "doing his bit". But is this all the physicist can contribute, the development of more and fancier weapons? Is the only contribution of physics, to the year-by-year needs of this country, to be more and fancier gadgets?

Perhaps the question can be discussed on a broader plane for a paragraph. Science and the scientific method have often been criticized for producing machines and weapons and then not seeing that these products are wisely or effectively used. In a rather fundamental sense, however, this criticism involves a contradiction in terms. Science and scientific techniques are not designed to make decisions, to carry on the basic operations of *administration*, such as running an army or a business. They have been designed to increase our understanding about some facet of nature, and while this increased understanding will make the task of some administrator wider in scope or will enable him to make his decisions more wisely or will reveal to him more fully the consequences of his decisions, it seldom will *make the decision for him*. The administrative decisions concerning the use of the products of science should be based on all the data available, but they nearly always involve other factors of politics or morale or personalities, which are nonscientific and which must be decided in an arbitrary sort of way. In many such cases it is more important that a decision be made than how it is made, which, of course, is a thoroughly unscientific attitude. It is not surprising, therefore, that the training and temperament of the usual administrator, military or nonmilitary, are quite different from those of the usual scientist. Science requires an attitude of skepticism and an impatience with arbitrary decisions; administration must eventually make arbitrary decisions and often is impatient with criticism. The conclusion of this bit of discussion is, I believe, that scientists may and should contribute

as citizens but, as *scientists*, they cannot contribute *directly* to the making of decisions concerning the use of the gadgets they have helped create. Some scientists, of course, have turned into very good administrators and it may be that all administrators would be helped by scientific training, but this is beside the point of the present discussion, which is that the process of making an executive decision is not a scientific activity.

But if science is reduced to helping in these decisions only indirectly, is physics' only contribution a continual production of new gadgets, to further complicate the problem? I believe not. I believe it is possible for a physicist to make an important contribution, as a scientist, in the running of the operations of civilization. He can provide this assistance by studying these operations rather than trying directly to make decisions about them, by helping to understand them as quantitatively and impersonally as possible. Here the object of study is the operation itself; the flow of goods and people in a city, the operation of strategic bombing, the requirements and limitations of a whole communication system are examples. This is not to say that the physicist should not contribute directly, *as a citizen*, to the reaching of decisions concerning these operations, nor is it meant to imply that there is no social value in physics itself; it is to say that the physicist has in addition the opportunity (and perhaps the duty) to contribute *as a scientist* to the clarification of the factual basis for these decisions, so that they may be made as wisely as possible.

It will be objected that the scientific study of the operations of civilization is the task of the social scientists, and that physicists should stick to their last, turning out more gadgets. I believe this objection was successfully refuted during the last war by the experience of the Operations Research groups working with the various branches of the services. These were mixed groups, including mathematicians and physical and biological scientists as well as social scientists (and even lawyers!), which studied various operations of war in a scientific manner and in close collaboration with the operations officer responsible for making the decisions concerning the operation. They worked out a quantitative picture

of the tactics of sinking a submarine, for example, or of bombing a city, how the results depended on the equipment involved and on the way the equipment was used, and presented this picture to the operations officer so he could issue his orders wisely and use his forces as effectively as possible. These groups worked out a possible symbiosis of scientist and administrator which, I believe, has very great possibilities for further application in other, less destructive, aspects of the operations of civilization.

Two aspects of the experience gained by operations research groups are germane to the present discussion. These are the importance of the mixed team of scientists, and the importance of close proximity between the scientist in this field and the administrator. It was found that physical scientists and mathematicians were at least as necessary, for an effective group, as were the social scientists. Nearly all the operations studied had aspects which were familiar to the physical scientist and which he was trained to analyze. The biologist and psychologist were necessary, of course, but most groups were not effective without representation from all the scientific disciplines. The writer is undoubtedly prejudiced, but he is firmly convinced that many aspects of economics and other social sciences will not advance appreciably until they are subjected to techniques familiar to the physical scientist.

The other element of novelty brought out in operations research is the importance in this work of close proximity of the scientist and the administrator. It is necessary for the scientist to learn from the administrator what problems are important, what decisions must be made and what aspects of the operation cannot be changed and why, so that his analyses will be effective ones and not academic futilities. Vice versa, it is important for the scientists to report their findings directly to the administrator so that he can understand, as completely as possible, the factual basis of the problem concerning which he has to make day-by-day decisions.

Returning now to the question posed in the first paragraph, I believe it is possible for physicists, as physicists, to contribute to the better use of the tools and weapons they have helped make. Those whose overwhelming desire is to make more gadgets, by all means take a summer or a year at Los Alamos or at NOL. But those who would like to help understand how things are used and see that they are used more effectively rather than to make more things, have opportunities to make important and urgently needed contributions.

As far as purely military problems go, each of the Services has an operations research group, on

which the higher commands now depend for day-by-day help. The group for the Army is the Operations Research Office, headed by Ellis Johnson, a physicist; that for the Navy is the Operations Evaluation Group, headed by J. Steinhardt, a physical chemist. The Air Force has two groups, the Operations Analysis Section of the Air Staff, headed by LeRoy Brothers, a civil engineer, and Project Rand (concerned with longer-range planning), headed by Frank Collbohm, an aeronautical engineer. The highest echelon group, reporting to the Joint Chiefs of Staff and the Secretary of Defense and concerned with combined planning, is a mixed military-scientist body called the Weapons Systems Evaluation Group, with Lt. General J. E. Hull as Director and H. P. Robertson, a mathematical physicist, as Deputy Director. Each of these groups has men in Washington, working closely with the planners and senior officers of the various staffs, and men in active theatres, working with the staffs of the forces in the field.

Each of these groups urgently needs men of experience and judgment, both in Washington and in the field, particularly at present. Each group can use to advantage scientists on short-term assignments, eight months, a year, in a few cases for just a summer. It is almost as important to increase the number of scientists back at universities and industrial laboratories who have had experience in this field, to constitute a reserve in case of all-out emergency, as it is to have men working in the field right now. There are developments in the nonmilitary side of things which merit support also. The National Research Council is in the process of organizing a Committee on Operations Research, to foster training in this field and to help extend activities to other governmental and commercial spheres. The possibilities in connection with communications, transportation, and fuel conservation, to choose at random, are obvious. At least one well known firm of industrial consultants is building a mixed team to develop the commercial possibilities of the technique.

The subject matter studied in operations research is not subject matter of physics, of course; one studies the interaction between machines and men rather than the interaction between mesons and nuclei. Perhaps this is a reason for physicists, who wish to stay physicists, not to work in the field more than a few years at a time. But for those who wish to contribute a part of their active life to helping use our material civilization more wisely, operations research offers an opportunity and a challenge.

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