

(e) Sea-See. A research vessel designed for observation of biological activity in the first 50 feet of the ocean's depth. The device utilizes plastic hemispheres which provide the observer with all-around visibility and will be useful for observation of fish schools, porpoise behavior, sea lions, and the operation of travel nets.

4. *Several agencies have set up procedures to appraise the performance of contractors that do research and development for them, or that manage agency laboratories. To your knowledge, what consideration has been given to applying the standards and procedures of these appraisal processes to Government-operated laboratories? To what extent would this be desirable?*

For any organization or individual to feel successful there must be some mechanism for measuring the degree in which they have fulfilled their goals. In an organization which is profit-oriented, such an evaluation is straightforward, rigorous, and simple. If the figures are in the black, all associated with the organization are happy. If they are in the red, or tending toward the red, then something must be done to rectify the situation. Government organizations, military organizations, educational institutions, and research and development activities, whenever they are adequately removed from the profit-making pressures, have a more difficult time in establishing a proper evaluation of the effectiveness of their processes and results. For all such organizations I believe the evaluation must be on the basis of competition similar to that involved in making a profit. The fact, however, that results cannot easily be expressed in terms of a single variable, such as money, tends to make the evaluation process much more difficult. Governments are judged by history, and military organizations by wars. These are very harsh and final judgments and do not provide a very adequate, self-rectifying mechanism.

In essence, the appraisal of contractor and laboratory performance is limited by the capabilities of the individuals available to perform the appraisal. Of necessity, an appraiser must be a person who has been very successful in the field being evaluated. Yet, every appraiser has his own set of biases and believes that his own approach is the only correct approach. The competitive system is the only appraisal system that leaves open the possibility of innovation.

In spite of these difficulties in evaluation, the Navy is setting up technically competent review committees to review laboratory performance. The effect of these committees on laboratory performance has yet to be evaluated.

5. *The DOD witness proposed the elimination of manpower controls on cross-agency work to promote flexibility similar to that available to the AEC contract laboratories. What is your opinion of this proposal?*

I believe that some form of manpower controls or ceilings are essential in the absence of competition or techniques for measuring the output of a laboratory. Independent of the size of an organization assigned any particular job, pressure will always arise to demonstrate the requirements for more people.

The difficulty of maintaining effective communication with increasing size of an organization is the reason, I believe, that organizations tend to become less efficient as they become larger. Dr. R. B. Kershner of the Applied Physics Laboratory, Johns Hopkins University, has written a very interesting paper¹ on the optimum size of organization for any given job. He plots the time to accomplish a given objective against the number of people assigned to the task and shows that the curve has a minimum value. With too few people assigned, the job moves too slowly to maintain the interests of the people and their sense of accomplishment. As a result, a long time is required to finish the job. If the number of people is increased beyond the optimum, competition for the jobs available becomes keen. Communications begin to fall off. The understanding of what is to be accomplished becomes more remote. The need for specific, definite specifications becomes greater. And, finally, the ability of each engineer to participate in setting the goals toward which he is working, and his contribution to the total design, becomes less with a resulting loss of interest. Tension within such an overstaffed organization grows, mistakes become more common, and the ability to try new things which might lead to significant short cuts becomes entirely too risky. The need for more coordination and more planning as the program lags becomes more apparent. The system is self-accelerating in that, as more coordinators are added, the engineers and scientists have less opportunity to provide feedback into the setting of specifications; thus, progress toward the final

¹ R. B. Kershner, "The Size of Research and Engineering Teams," in *The Proceedings of the Eleventh National Conference on Administration of Research*, Penn State University Press, September 1957, pp. 77-83.