

than in a commercial facility. Within a profit-motivated firm, there is a latent conflict between an atmosphere of freedom, which is necessary for good scientific endeavor, and the necessity of direction from those who are responsible for the conduct of the firm.¹⁶ In addition, it appears that those firms which have had the greatest success in basic research have moved furthest toward creating a university environment within their facilities.¹⁷ While additional corroborating factors could be mentioned, it is sufficient to remark that we should not be surprised if the major advancements in medical science are achieved in laboratories outside the pharmaceutical industry.

At the same time, moreover, there are a number of reasons why highly applied research and development activities are best carried on within the confines of the industry. Not only do these tasks assume a highly routine character which tends, in a large number of cases, to make them uninteresting to university scientists, but also the relevant procedures are sufficiently well understood so that they may be reasonably well directed. An atmosphere of completely free inquiry is not crucial where both the goals and the procedures are relatively well defined. These considerations, moreover, may explain the fact that although the pharmaceutical industry provided approximately 30 per cent of the total funds for medical research in 1960, it utilized only 12 percent of the total number of persons doing medical research with the Ph.D. degree and only 5 per cent of the total number doing medical research with the M.D. degree.¹⁸

Even more important, however, are the economies that are likely to result from combining applied research with production in the same organization. Within a technical industry, the road from laboratory to factory is not level or direct, and large gains may result from institutional arrangements that provide the smallest possible barriers to the flow of information. To insure a free and unrestricted flow it is probably necessary that the latter stages of research and development, as well as production, are undertaken within the firm.

It is interesting, in this regard, to note the conclusions of a recent study that contrasted the American and Soviet pharmaceutical industries. Unlike the United States, research and production are carried on by completely separate agencies in the Soviet Union. The authors report that as a result of this arrangement, "there are difficulties of communication and coordination between [research] institute and factory which constitute a major bottleneck in getting pharmaceuticals into production."¹⁹ While the divorcement of research from production represents merely one additional factor out of many that distinguish the Soviet industrial structure from that of the United States, still the apparent results from this divorcement do seem to point to a major set of problems.

The division of labor that exists between industry emphasis on product development and non-industry emphasis on the more fundamental areas of research provides a system that is rational in principle although we know little of whether the optimal share is more or less than the 30 per cent presently occupied by the industry. If, however, our concern is with the use and possible misuse of such scarce and limiting factors as highly trained personnel rather than merely with dollars, the quantitative problems appear in a different perspective. A large drug-industry effort does not divert, to a substantial degree, scarce resources from university and government laboratories to its own facilities but, rather, uses, for the most part, a different and non-substitutable class of personnel. Thus, the opportunity cost of industry research in terms of non-industry research is likely to be relatively low.

When evaluated on its own terms, it seems clear that the industry accomplishes an important research task in a generally effective manner. It has been responsible for a large number of pharmacological modifications and improvements that have been introduced as well as for an acceleration in the process of testing and developing new drugs, and both of these gains provide a high degree

¹⁶ This "conflict" is discussed in John Jewkes, David Sawers, and Richard Stillerman, *The Sources of Invention* (New York: St. Martin's Press, 1958), chaps. vi, vii.

¹⁷ See, e.g., the statement by James B. Fisk, "Basic Research in Industrial Laboratories," in Dael Wolfe (ed.), *Symposium on Basic Research* (Washington, D.C.: American Association for the Advancement of Science, 1959), pp. 159-67.

¹⁸ National Institutes of Health, *Manpower for Medical Research—Requirements and Resources, 1965-1970*. (A Report for the Committee on Appropriations [Washington: U.S. House of Representatives, February, 1962]), p. 24.

¹⁹ Raymond A. Bauer and Mark G. Field, "Ironic Contrast: U.S. and U.S.S.R. Drug Industries," *Harvard Business Review* (September-October, 1962), p. 93.