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TWO CULTURES IN THE LABORATORY

The public at-large has shown increasing interest in what goes on in the laboratories dedicated to research and development in our nation, and this is fostered by an increasing attention to these matters in the public press and on television. The public, however, is sometimes confused about what actually transpires, and particularly about the purposes and intents of the people responsible for the action. This confusion, it appears to me, is in part due to the ill-advised use of certain terms, and sometimes it is the scientist himself who is responsible for the confusing usage. It is my purpose in what follows to try to find some useful order in what currently approaches chaos.

There are two quite distinct cultures in this country. One of these is housed largely in the laboratories of our universities and medical schools. The other is the predominant activity of the laboratories of the industrial sector. In the academic environment there is opportunity for science to prosper. "Science" derives from the Latin word for knowledge. It treats [largely] of ideas and stands in contrast to technology, which is emphasized in many industrial laboratories. "Technology" stems from a Greek root meaning art or craft. It deals largely with things--materials, instruments, machines, and sometimes methods. Science and technology are both among the creative activities of the human mind and the human hand. They are extraordinarily valuable activities. They are interdependent and they interdigitate very closely, but they are not the

same. The frequent linkage of the two words by the conjunction "and" does not in any sense imply identity, any more than it does for "bacon and eggs." It is generally relatively easy to tell the bacon from the eggs. It is also relatively easy usually to distinguish the science from the technology. Science progresses through the performance of research, while technology proceeds by the conduct of development. Again, as with bacon and eggs, although research and development (R & D) are often spoken of in one breath and often appear as a single budgetary item, they are not identical. In almost every instance, the person working in the laboratory will know perfectly well whether he is doing research or doing development. It should be noted that the very same person may alternate his activities between research and development. Thus, he may spend the morning developing an instrument or a method in order that he can apply it to a research problem in the afternoon devoted to an understanding of a fundamental mechanism.

The goals of the two activities are also distinct. Research, if successful, leads to discovery; and discovery, in turn, leads to publication. Development, on the other hand, leads to invention; and invention, if deemed meritorious, leads to patents. The rewards of publication are manifold and include ego-gratification, a possibility of academic promotion, and an increase in likelihood of success in the competition for research support. In the rare instance it may also lead to the capture of a prize. Whereas the acquisition of patents may also have many gratifications, the one which clearly predominates is money. These matters are summarized in Table 1.

Whereas these two cultures are distinct and different in their origins and in their purposes, they relate to each other in many ways. The advance of science is critically dependent upon many technological developments, such as the invention of a novel analytical instrument or the development of a useful chemical synthesis. Conversely, the development of technology is critically dependent upon the knowledge which is generated by scientific research. Certainly practically every major technological development in the past can trace its origins back to scientific research which was fundamental to the developmental process.

It should, of course, not be supposed that research is the peculiar domain of academia, and development the exclusive pasture of industry. This line has frequently been crossed and in both directions. The stress, however, is perfectly clear. Whereas publication is the highly respected product--indeed, the currency--of academic research, patents are an important expectation of industrial development.

It is my belief that this dichotomy has proven valuable and is, in general, a good thing. Both channels must proceed if the totality of purposes is to be achieved. A quenching of scientific research could soon lead to the exhaustion of undeveloped knowledge, while a failure of technological development would certainly markedly slow down the progress of science.

Whereas science and scientists may have a slightly tarnished image at this time and in this country, the United States continues to have a love affair with technology. We love our automobiles, our airplanes, our

calculators, and our kitchen appliances. It is notable that as our children progress through the school system and are repeatedly exposed to courses in American history, they learn a good deal about Thomas Alva Edison, Samuel F. B. Morse, Alexander Graham Bell, and Eli Whitney. But do they ever hear of Joseph Henry, Josiah Willard Gibbs, A. A. Michelson, or Robert A. Millikan? In most general history courses, science as such receives short shrift despite the enormous contribution which scientific research has made to our present way of life. Recently, technology has come into prominence in such widely used phrases as "technology transfer" and "technology assessment." Curiously, we do not hear much about either the assessment or the transfer of science. Even in the field of medicine, it would appear that it is technology rather than science which must be transferred from the laboratory centers to the physicians in the hustings. This suggests that we are expected to treat our patients with new pills and new procedures but not with new knowledge.

The stress on technology in the absence of an offsetting stress on science is not without hazard. Technology leading to patents is certainly fiscally more immediately rewarding than is scientific research. During the affluent period when scientific research has been very generously supported and academic centers were not in financial distress, scientific research has of course flourished. As academic centers find it increasingly difficult to balance their budgets, as universities and medical schools are forced to cut programs, as Federal and other support of scientific research fails to keep pace with inflation, a new pressure will surely

develop in the academic laboratories. One can imagine that the university officer whose responsibility it is to balance the budget may feel constrained to put pressure upon the scientists who are conducting research in the university laboratories to urge upon them to select product-oriented problems which may lead to remunerative patents. Thus, the financial officer of the university will behave very much as the director of development in an industrial situation must behave. Such pressure could, in fact, upset the present apparently satisfactory balance between the two cultures which we have described. The occasional development of a patentable discovery in the course of a research program has of course occurred and will continue to occur. Notable examples are the oft-quoted discoveries made by scientists at the University of Wisconsin, leading to the establishment and subsequent success of the Wisconsin Alumni Research Foundation. This, however, is quite another matter from the exertion of administrative pressure upon academic scientists to dedicate themselves toward patentable invention. Technological development will always continue to take place in the cellar of the individual inventor, in our great industrial laboratories, and from time to time in academic institutions. Scientific research, however, is so heavily concentrated in these academic institutions that if they should become inhospitable to this activity it would find no other place to go.

Table 1

The Two Cultures

Academia		Industry
↓		↓
Science	(and)	Technology
↓		↓
Research	(and)	Development
↓		↓
Discovery		Invention
↓		↓
Publication		Patents
↓		↓
Gratifications*		Money

*See text