Cost-Research Differential

In his editorial for 22 April Wolfle discussed a recent report showing that expenditure on research has increased faster than research effort itself. Along with the inflationary influences Wolfle mentioned as causes of this differential, the fall-off in research productivity per dollar spent may be due in part also to the diluent effect of the so-called "information explosion," a natural consequence of the intensive recent work in some of the newer (or more fashionable) sciences. This effect can be described mathematically in a crude way as follows:

When an individual (or a team) sets about to do a piece of research, he has available to him a body of knowledge, x, pertinent to his field, of which some fraction, r, will be found to be helpful in the work; in other words, the larger the product, rx, the faster will the job progress. On the other hand, the larger x is, the longer it will take to sift it through in order to uncover the useful portion. Thus the time, t, required to complete the job can be written:

$$t = f_1(rx) + f_2(x) \qquad (1)$$

where f_1 is a decreasing function and f_2 an increasing function. Depending on the nature of these functions, there may be a value of x that brings about a minimum time for accomplishment, which would of course occur when:

$$(d/dx)\,[f_1(rx) + f_2(x)] = 0 \qquad (2)$$

We may now have passed this saddle-point in certain of the very active new sciences and should not therefore be surprised to see a drop in productivity. The increasing ratio of "support personnel" to "professionals" in research establishments seems to reflect this. More peons are needed to turn the sifters!

It should also be noted that under these circumstances it does not always pay to make an exhaustive search of existing knowledge, especially when the object is to get results quickly, not to compile an impressive bibliography. In effect the search is then restricted to some smaller sample, so as to approach the condition of Eq. 2. It often takes less time to do it all over again than to find out how someone else did it earlier. This is, in fact, common practice in industrial research, ordinarily conducted for internal application. Unfortunately, the result is that often very original findings lie buried in company files for years, simply because no one wants to bother with the documentation required to meet the punctilios of formal publication.

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Integration and Confrontation

Luther Carter's "Integration: Negro college hires an impatient Briton" (News and Comment, 22 April) exposes many of the problems of the Negro college striving to meet the uncertain demands of integration and to maintain a prominent place in a changing society. It is clear that as integration of Negro colleges progresses there will be many incisive observers chronicling these events and that one of the major "losses" will be the cloak of anonymity in regard to standards, practices, and scientific approach which cultural exclusion has provided. It is probably not necessary to choose sides over the specific activities of the Hodkinsons—black and white—who choose to be the focal points and spark plugs of social change, but it is necessary to choose sides over the question of the need to get on with the process of confrontation per se. That the larger scientific community chooses to be aware of and involved in the problems of this important but neglected part of the educational system bodes well for the future.

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Research Administrators, Government and University

Professor Easton West travels to Washington once every three months, where he serves on a national panel which identifies fruitful areas for research support in his field and decides on allocation of research grants to his colleagues in major universities of the nation. He communicates effectively and frequently with the responsible officers in his field at NSF, NIH, ONR, AEC, and NASA; they rely on his scientific judgment, he trusts their judgment on overall budgetary and interagency matters, and they discuss long-range plans with mutual respect if not always with agreement. Professor West begrudges the time away from his laboratory; but he has come to consider the two days per quarter he spends in Washington as an important contribution to his field and to education generally and, on the whole, a rewarding investment of time.

Meanwhile, back at the University, Professor West has watched his field of research evolve and has become increasingly aware that the structure of courses and departments in his field is badly out of date and that the relative emphasis given to undergraduate, graduate, and postdoctoral training is inappropriate. He concludes that certain courses should be revised, new laboratories built, new research and teaching appointments made in his department and in a related department. He assumes that the University administration shares his sensitivity to the changing scientific and governmental environment and is as anxious as he is to increase the University's effectiveness in teaching, research, and public service. Professor West therefore seeks out the university administrators who are likely to be concerned with his suggested changes: several deans and vice presidents, the comptroller, the coordinator of research, the business manager, the director of the physical plant, and the campus architect. Professor West realizes that the issue he presents to the administration is difficult, demanding choices between competing fields and the exercise of discriminating judgment. However, in the administrative labyrinth, he encounters little understanding of the problems which seem to him important and little of the strongly motivated search for new solutions which is characteristic of many of the key administrators he knows in Washington. He is thoroughly frustrated and concludes that the University administration is not equipped to cope with problems having a high technical content.

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This parable of contrasts illustrates a situation which exists at very many universities. Two aspects may be recognized. First, the size and complexity of the university has outgrown the system of academic deans which was created in simpler days to manage a relatively homogeneous group of scholars and scientists in a small number of stable fields. Academic administrators now seldom make the most crucial decisions affecting the active academic fields. They are fully occupied with a myriad of matters of greater immedi-

acy; and, in any case, they cannot have the specialized backgrounds required in the many technical fields under their jurisdiction. Second, day-to-day management of a modern university requires a vast number of nonacademic administrators who have no special orientation toward the university or its purposes and who could just as well keep the vital "paper gas" flowing in business or government. In many cases they make decisions which impinge strongly on scientific or academic issues. It is symptomatic of this situation that the study "The Administration of Government Supported Research at Universities" (News and Comment, 29 April) was carried out by the Budget Bureau rather than by the universities. Inaction by the universities on this matter would be expected if the government were engaged in trying to reduce support and curtail the freedom of universities to manage federal funds. The reverse is true, and we now have the Budget Bureau suggesting "research agreements" to replace research grants or contracts. The research agreement presumably would fit the nature of most university research more appropriately than the grant or contract does and would enlarge the area of freedom of the research scientist or at least legalize the freedom he already exercises. It may also serve to shift responsibility for allocation of funds from the granting agency to the university administration.

But in order for the proposed system to operate effectively there must be an impedance match between federal and university administrations; at present many scientists have reason to believe that the match is poor indeed. There is widespread doubt that universities are capable of managing research funds wisely or of making the crucial decisions which will influence science in fundamental ways.

Universities would do well to borrow a page from the book of the federal agencies written since World War II. This book teaches that a proper impedance match between the scientific community and government agencies has been achieved when active and leading scientists have a significant role in policy and in budget allocations and when the government administrator has training and background in the field for which he is responsible, knows the scientists in his field and their work, and is encouraged by his agency to seek new ways to advance his science. The parallel in the university would find for each broad and active research field a dean who knows the overall field closely. The dean would work closely with an advisory panel of scientists, including members from other universities, and they would jointly be responsible for allocation of funds for education and research and for decisions affecting the future of the field in other crucial ways. A structure of this sort, combining specialized knowledge and administrative responsibility, is essential if universities are to assume the more important role which is implied in the Budget Bureau study.

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International Education Dialogue

The recent congressional hearings on the International Education Bill show the growing interest of the U.S. government in funding programs for international studies. All persons concerned with the crisis in education in developing countries welcome our widening interests, but they wonder if our new plans offer a genuine dialogue.

They demand both technical assistance and associated science-teaching programs, but rarely can we give assistance without adding our social ideas as part of the package. Much as the developing countries call for a wide variety of assistance programs to become effective, it is hoped, before they and we are overwhelmed by problems of survival, they need dignity and acceptance as colleagues working for the common good. Other nations see much of our international dialogue polarized into an offensive parochialism as a price for assistance. Our ideas of science education are exported, and much of this is right, but in this process there is little humble search for new ways of seeing others and understanding ourselves.

There are now several centers, in addition to the Division of Science Teaching at UNESCO, for collecting information on science education programs in various countries, but none is based on service as a means to obtain information and create the needed climate of friendly inquiry between different peoples and between physical sciences and the social sciences such as cultural anthropology.

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