

Book Reviews

The Technology Gap: Causes and Consequences

Fundamental Research and the Universities. Some Comments on International Differences. JOSEPH BEN-DAVID. Organisation for Economic Co-operation and Development, Paris, 1968. 111 pp., illus. Paper, \$1.50.

The publication by the OECD of this book by Joseph Ben-David provides one with yet another reason for acknowledging the excellent work of the OECD's Directorate for Scientific Affairs. Under the leadership of Alexander King, the Directorate ranks among the world's foremost centers for the study of public policies toward science and technology. On the level of action, the Directorate has been instrumental in guiding individual governments with respect to the development of more effective science policies and in stimulating cooperation among the science ministers of the 21 member states. Natural scientists, government science officials, and students of science policy owe a considerable debt to the pioneering activities of King and his associates.

The significance of Ben-David's monograph is that it raises the analysis of science policy to a new level of sophistication and opens the way for comparative evaluations of the effectiveness of different policies for science and of alternative methods for organizing national scientific-technical activities. This is the social science of science at its theoretical and practical best. Whether or not they agree wholly with Ben-David's analysis and recommendations, students and practitioners of science policy and organization have been provided with a challenging theoretical framework which will benefit their researches and actions.

Ben-David, an Israeli sociologist, had as his original mandate the task of measuring and accounting for the present gap between the United States and Western Europe in scientific technology. As he says in his introduction, this

definition of his task proved to be too narrow. "Ideas about the measurement of scientific production in different countries, about the relationship between fundamental research and the performance of the economy and the optimal kinds of research organizations have to be universally valid. They should be applicable to all countries and not only to the United States and Western Europe" (p. 15).

Ben-David's central thesis is that the science gap between the United States and Western Europe originated in the latter part of the 19th century because the former succeeded and the latter (with the partial exception of Great Britain) did not succeed in adjusting to the then emerging requirements for the production of scientific knowledge, specifically, the displacement of the artisanal mode of scientific research by the modern laboratory organization, the fission of the traditional 18th-century disciplines such as anatomy and chemistry into a multitude of highly specialized research areas, and the introduction of systematic training in research. While all these developments began in Western Europe, their full flowering there was arrested because of the social-political structure and in particular the organization of the European university.

"The research institutes of Western Europe had not become graduate schools, the new fields of research had not been incorporated in the university structure, the new researchers had to seek their careers in traditional academic frameworks, and only occasionally were they offered acceptable alternatives in governmental or industrial research" (p. 34). In the United States, on the other hand, educational and scientific leaders had a clear field upon which to create a university structure consistent with the new conditions of scientific achievement including a decentralized system of financially auton-

omous universities and the departmental method of academic organization.

Most important of all, three traits have characterized and accounted for the relative success of the American scientific system. The first is the high degree of entrepreneurship forced upon scientists and university presidents by the need to compete for funds; though this situation can lead to crass grantsmanship, it also accounts for the dynamism of the system. Second is the high productivity of American science: "Western Europe may equal or surpass the United States in its support of fundamental science but, from the point of view of providing conditions for scientific productivity and creativity, Western European efforts fall short of those in the United States" (p. 52). The third differentiating trait of American science is its close association with application. This is beneficial for basic science in two ways. First, the problems associated with application can lead to the refinement and development of the basic sciences. Second, and more important, basic science in the United States is considered a "social overhead expenditure on investment" and for this reason can be funded more generously than in Europe. "The European pattern of spending—relatively little spent on both fundamental and applied research with a relatively (to the United States) high percentage of the total going to fundamental research—reflects a situation where, (a) science is not very widely used so that investment in applied research is not worthwhile, but, (b) the countries are compelled to spend on fundamental science, irrespective of the burden on the economy, because of the desire to keep pace with new developments, the rate of which is set by the United States" (p. 52).

The preceding statement takes us to the second major concern of Ben-David's study, namely Europe's backwardness in applying science to technology. Here Europe faces a serious dilemma in that "trying to make science more useful for practice in the common-sense way, by preferring research projects with obvious practical applications, will be self-defeating." The major breakthroughs in science-based technology have been and will be those which were not and cannot be anticipated and planned. In seeking an escape from this dilemma Ben-David contrasts two views on the relationship of science and technology. The first view is that the practical benefits which

flow from scientific discoveries are a matter of random chance and that nothing can be done to accelerate the conversion of new knowledge into new technology. The second, and the more prevalent view today, is that there is a systematic relationship between scientific and technological growth; the advance of the former by necessity contributes to the advance of the latter. Ben-David's position is that, though there is no necessary connection between scientific and technological activities, steps can be taken to increase the probability that scientific advances will be exploited by technologists. This means increasing the motivation and the opportunity to find uses for science.

"The purpose of policy should, therefore, be to influence the likelihood of these chance occurrences [between scientific knowledge and practical needs] by increasing the density of both kinds of activities and the velocity of the circulation of ideas and problems from both areas of activity in spaces which ensure interaction. Increasing the density is a matter of investment, velocity is the result of entrepreneurship, and creating the properly enclosed spaces is a task for organization" (p. 61).

The creation in Europe of these necessary conditions for rapid scientific and technological advance is the third concern of Ben-David's study. He begins by noting a widespread consensus in Western Europe with respect to the need for reforming scientific research and education: the establishment of larger research facilities, especially of a multidisciplinary nature, the suppression of the chair system of university organization in favor of the American departmental system, and the development of graduate training in science. But there is little consensus when it comes to the reform of the university itself or of the overall national system for the support of science. With respect to these larger and basic issues Europeans may be divided into the "reformists" and the "revolutionaries." The "reformist" position is that the European system for the support of science is basically sound; the problem is principally one of inadequate financial support and of establishing new institutions to support new fields of research which cannot find a home either in the university or in industry. In other words, Europe's backwardness can be overcome by tinkering with and adjusting the existing system. The "revolutionaries," on the other hand, believe that

Europe's problem is long standing and inherent in the European science system itself. "The relative backwardness of European science in certain fast-growing fields is, according to this view, only a single instance of the chronic weakness of the system to take up fast-growing fields altogether." What is required, therefore, is not minor organizational alterations but structural change. The overthrow of the existing system in favor of a system resembling that of the United States should be the goal of national science policies.

What Europe needs, in Ben-David's view, is a strategy which over time will transform European scientific and technological institutions. Specifically, he advocates that governmental funds for research and higher education be allocated on the basis of institutional merit and in a manner which would leave the details of policy-making to the institutions themselves. Secondly, he advocates exchange and mobility, especially among the European states, in order to stimulate competition and entrepreneurship.

As Ben-David cogently demonstrates, and I have sought to show elsewhere with respect to France [*France in the Age of the Scientific State* (Princeton University Press, 1968)], the task of transforming the European system will not be an easy one. What is involved is the altering of essential features of European social-political life: limited social and geographical mobility, over-centralized decision-making for science and the absence of strong, financially autonomous universities, the existence of national boundaries which prevent the creation of a European Common Market for brains, and the separation between the university and the economy. Unfortunately, the creation of an environment which would benefit science and technology is strongly resisted throughout Western Europe. Powerful academic and administrative interest groups prevent needed reforms of the European university system. One of the ironies of the present situation in fact is that those groups which are on the left politically and represent change are most conservative with respect to reform of the university. One cannot expect, therefore, to see the needed reforms come out of the protests and upheavals currently convulsing European universities.

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Accounting for Aborigines

Origins of the American Indians. European Concepts, 1492-1729. LEE ELDRIDGE HUDDLESTON. Published for the Institute of Latin American Studies by the University of Texas Press, Austin, 1967. x + 179 pp. \$5. Latin American Monographs, No. 11.

The quiet title of this book gives no hint of the painstaking care with which the author has found, studied, and compared the works of the bickering European writers who, misquoting and plagiarizing each other for over two centuries, sought to explain the presence of man in the New World. While some might call the book history and others might call it anthropology, it emerges as an important essay in the history of ideas.

The most reasonable and economical explanation of the presence of red men in the Americas is the now commonly accepted one that the human population was derived from Asia. In addition to being commonsensical the idea is supported by many biological, archeological, and geological data. This is the "modern" view, resting on current research. Among laymen another popular and widely held belief is that the original American population was derived from Europe or the Near East, with the ten lost tribes of Israel usually being credited with the colonizing voyage.

Thanks to Huddleston we can know that the theory of an Asiatic origin, supported by logic applied to scant but empirical data, was first put forward by Joseph de Acosta, a Spanish Jesuit scholar, in 1589. So much for modern thought. And the ten-lost-Hebrew-tribes theory was not proposed by Vespucci, as is often claimed, but was proposed much later.

The history of speculation on American Indian origins, as Huddleston traces it, goes thus:

The earliest writings about the American Indian (by Columbus and Vespucci, among others) reveal no curiosity about origins, but by 1530 the fact that a New World—a land unaccounted for in theological knowledge—had in fact been discovered led to great scholarly uneasiness and the necessity of finding an explanation. Moreover, this explanation must fit into theological dogma, including both the creation myth and the story of Noah and the ark. In those days, of course, scholarship was largely the province of the clergy. Inevitably