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Scientific Policy in Britain

The central issue is that of determining priorities in the light of available money and manpower.

Alexander Robertus Todd

Before I attempt to discuss scientific policy in Britain, perhaps it would be helpful to consider first why countries need concern themselves at all with scientific policy. Why is it necessary to introduce this new kind of policy at all? To answer this question in full detail would require a treatment too elaborate for inclusion here, but the essentials of an answer can be given fairly easily. The past hundred years have certainly brought about a greater change in the material aspects of civilization than occurred in the whole previous history of mankind. Not only has the speed of change been staggering, viewed over this period as a whole, but the rate has been continuously accelerating, and at present there is no sign of a slackening. And all the changes that have occurred can be attributed to science and to the modern form of technology which is the application of the scientific method and the results of scientific research to the problems of industry, agriculture, medicine, defense, and administration. As a result, science and technology now permeate almost every aspect of public and private life and they have had a profound effect on our social systems, which have been slowly evolving over many centuries. The trouble is that, although science and technology advance very rapidly, social attitudes and social patterns are slow to change, and it is the disparity between the rate of change in science and that in social behavior in its broadest sense that lies at the root of most of the stresses and strains in the world today. It is this that has been responsible for devastating wars in this century and which has caused the appearance of all sorts of political systems—communism, capitalism, socialism, fascism, and all the rest. All these political and politico-social experiments can be regarded as attempts to come to grips with this disparity in rate of change.

If my thesis be correct, as I believe it to be, then it follows that a country's policy on both the national and international levels must be affected at almost every level by scientific and technical considerations. It is therefore necessary that the country should seek to develop a coherent scientific policy through which it can seek to ensure that its scientific and technological knowledge and potential are deployed to maximum advantage. This fact now seems to be slowly gaining general recognition, and in recent years the number of countries seeking to establish a basis for scientific policy has been rapidly increasing, although the methods which are employed vary somewhat according to political and ad-

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ministrative differences. Britain was one of the first countries to take up this problem. There were good reasons for her being early in the field, but to make them clear and at the same time to give you a picture of scientific policy in Britain, I must look at scientific developments in Britain historically.

The Two Industrial Revolutions

When the industrial revolution dawned, at the close of the 18th century, Britain was already one of the most prosperous countries in the world. She had a settled society, a sound agriculture, and world-wide trading interests which were pouring wealth into the country. The loss of her American colonies had not greatly affected her situation, since her links with the rich resources of India and the Orient were of vastly greater material significance. By chance she was well endowed at the time with inventors and also with able entrepreneurs (in some cases the inventors themselves) whose efforts ushered in the new industrial era in a country rich in coal and iron ore, the sinews of the industrial revolution. It is important to remember, however, that the industrial revolution of that period (I prefer to call it the first industrial revolution) rested on the kind of technology that had been used throughout earlier centuries—that is, the application of chance invention to practical ends—and was not at all scientific. The steam engine was perhaps the most important invention from the standpoint of the industrial revolution for it placed almost unlimited power in the hands of mankind for the first time; but the invention of the steam engine had nothing whatever to do with science. Britain took to the new industrial possibilities with astonishing vigor, and by the middle of the 19th century she was right in the forefront as the workshop of the world and was probably its greatest industrial power.

It was about this time, however, that the second industrial revolution began —the second industrial revolution which is still in progress. As I have said, the first industrial revolution had nothing to do with science, which, although it had been making slow but steady progress ever since the so-called scientific revolution of the 17th century, had been largely in the hands of amateurs and had very little effect on industrial progress. But soon after 1850 men began to apply the method of scientific research directly to the solution of industrial problems. I shall not attempt to give specific examples of this here, but there are many good ones to be found in my own field of chemistry which gave birth to the chemical industry we know today. It was this new approach which ushered in the second industrial revolution and set the pattern for the future.

The next 50 years were still outwardly the heyday of Britain's industrial power, but the seeds of trouble were already there. Perhaps she had been successful too early and her industrial pattern had been too solidly set; perhaps her social patterns were too rigid and the country-gentleman tradition of the upper classes, toward which the new industrialists strove, too strong. One can argue almost indefinitely about the relative importance of these and other factors, but, whatever the reason, the truth is that Britain was much slower to take advantage of the second industrial revolution than of the first. She made at least her fair share of scientific discoveries, but she did not apply them as avidly as some other countries did. For example, the dyestuff industry really originated in the early work and discoveries of Perkin, Nicholson, and others in Britain but it was, in fact, mainly developed in Germany and Switzerland during the period I am discussing. Of course, it is true that other countries, like Germany and, indeed, the United States, coming later into the field of industrial development were able to profit by the earlier British experience and, not having the same deadweight of established industrial pattern, were able to take to the new science-based technology with fewer inhibitions. Young countries are always ready to adopt new techniques; in more recent times the astonishing rise of Japan as an industrial power illustrates the same point.

The Haldane Report

However this may be, when World War I broke out in 1914 Britain very quickly found that she had allowed herself to become dependent on other countries (and in particular on her enemy Germany) for rather a lot of the products of the advancing science-based industries—for example, drugs and dyes. This might have been brushed aside as a temporary emergency only, but there were far-sighted men both inside and outside Government in Britain who clearly recognized that this weakness in science-based industry was also a long-term threat to the country's future. Even during the desperate years of struggle a committee was set up under Lord Haldane to consider the situation, and an organization designed to cope with it was set up—the Department of Scientific and Industrial Research. The Haldane report is a milestone in the development of science in relation to Government in Britain and is indeed a remarkable document which, even today, is astonishingly fresh and relevant. I believe its general philosophy to be still applicable in its essentials today, and not only in Britain, although, of course, the detailed pattern of developments that follow from it would differ in form according to the political constitution of the country in which it was applied.

In brief, the Haldane report recognized the need to promote the application of science in industry and to stimulate industrial firms to technological innovation based on scientific knowledge. Government had a clear interest in this, for economic and military reasons. But the report also recognized the need for Government to promote broadly based technological studies as a background for industrial development and for the day-to-day work of the executive departments of Government. It further recognized that none of this could be done without an adequate supply of trained scientific manpower and that it was therefore necessary to promote science and scientific research in universities. It therefore recommended that Government should provide grants to enable promising graduates to be trained in the methods of scientific research and should make available grants to university departments to meet the costs of special researches which they might wish to undertake and which could not be financed from their normal university budgets. Haldane and his colleagues were firmly of the belief that there would be great danger in placing an organization charged with any or all of these duties under a minister in charge of an executive Department of State, since they felt that it would inevitably become influenced by the day-to-day exigencies of such a department and would suffer both in respect of financial provision and of the degree of freedom which they considered essential to the progress of scientific work.

Fortunately, under that remarkable phenomenon the British Constitution the necessary instrument was ready to hand in the Privy Council. Her Majesty's Privy Council, I should explain, is a body whose nature and function is not very widely known even among Her Majesty's subjects, but it is in fact a link between the monarch and Government. It is presided over by the Lord President of the Council, who is a member of the Cabinet as a minister without portfolio—that is, a minister without executive departmental responsibility. (Such ministers without portfolio are extraordinarily useful for taking care of new activities in their experimental stages, or for providing members of the Cabinet who are free from departmental worries and so have more time to think.) Accordingly, as a result of the Haldane report the Department of Scientific and Industrial Research was set up to cover all the tasks I have mentioned; it was governed by a Privy Council Committee for Scientific and Industrial Research and was thus under the loose but benevolent surveillance of the Lord President of the Council. Later, other, similar bodies were formed with the same kind of organization—the Medical Research Council, the Agricultural Research Council, and, more recently, the Nature Conservancy, which was formed after World War II. Each of these bodies was financed by an annual grant which it negotiated with the Treasury on the basis of its own estimated requirements, and the disbursement of the money was in the hands of the Research Council, which was composed of independent scientists and industrialists serving for several years at a time on a rota system of appointment (*1*).

The system thus laid down operated until the end of World War II without any substantial change. Each research council operated certain research institutes or units of its own which pursued fundamental or background research [for example, the National Physical Laboratory, the Building Research Laboratory, the Road Research Laboratory, and so on, under the Department of Scientific and Industrial Research (DSIR), the National Institute for Medical Research under the Medical Research Council, and the Rothampsted Experimental Station under the Agricultural Research Council], and each research council supported university research by making training grants to students and special research grants for equipment and facilities. In the interwar period the system worked on the whole very well, and this period also saw the rise of the industrial research associations, which are now a rather characteristic feature of British industrial research. About 45 in number at present, they are cooperative research associations covering various sectors of industry, being supported by subscriptions from individual firms in the industry concerned and a proportional grant from Government made through DSIR, which is thus a partner in the enterprise. Their function—to encourage research in individual firms, to provide scientific information services, and to do research on topics of general import to the industry—has been performed with varying degrees of success; some have been very successful but others have found it difficult to make a real impression on some of the more backward industries.

After the War

It was World War II and its aftermath that really brought the question of scientific policy to the fore in Britain. The need for a broader look at the country's scientific pattern had indeed begun to trouble some people before the war, but our situation at the end of the war made such a look imperative. For we were in a parlous state—not only exhausted but impoverished, with debts on every hand instead of assets. Many of our cities were partly destroyed, as well as some of our industrial potential, and our industrial economy had been distorted to meet the needs of total war. Experience during the war had revealed, too, that both scientific research and development were increasing enormously in cost. In some areas, such as atomic energy, it was evident that the magnitude of the operations necessary would make it impossible to accommodate them in the existing pattern of institutions (indeed, a little later we had to create a new type of organization altogether—the Atomic Energy Authority—to cope with it). It was clear, too, that steps would have to be taken to increase our supply of scientific manpower if we were to keep pace with industrial progress, and there were likely to be serious problems in getting Government to devote the large sums necessary to research in a period of general financial stringency.

Perhaps it was the financial aspect which finally persuaded Government to take some action. It had been all right to proceed in the rather free-and-easy way we had done between the wars; there had been little friction because the total sum necessary to keep science and technology happy had been very small in relation to the national budget. But as soon as this total showed signs, as it did after the war, of becoming a significant fraction, the British Government, like any other government, began to have second thoughts.

But whatever the final spur may have been, the fact remains that, following upon various studies and consultation with scientific authorities, in particular the Royal Society, Government formed, in 1947, two policy-making bodies, the Defence Research Policy Committee, concerned (as its name suggests) exclusively with defense policy, and the Advisory Council on Scientific Policy (ACSP), covering the whole field of civil science. Coordination of policy in these two spheres was to be assured by the appointment of the late Sir Henry Tizard as chairman of both bodies, an arrangement which was terminated when I succeeded him as chairman of the Advisory Council on Scientific Policy in 1952. Thereafter coordination was effected—although perhaps not as completely as it should have been—by cross-representation on the two bodies. The ACSP was given wide terms of reference "to advise the Lord President of the Council in the exercise of his function for the formulation and execution of Government scientific policy." Later, in 1959, to underline the importance which it attached to scientific policy, Government created the post of Minister for Science, and ACSP then became responsible to him, with unchanged terms of reference.

The ACSP was charged *inter alia* with the responsibility for keeping under continuous review the problem of the supply of and demand for scientific manpower, and its standing committee dealing with this matter has for the past 17 years issued regular reports on which Britain's educational policy as regards the supply of scientific manpower has been based. In its composition ACSP was somewhat unusual, containing 12 members half of whom were officials (the secretaries of the four research councils, the chairman of the University Grants Committee, and a senior official of the Treasury), the remainder being independent scientists and industrialists appointed for a term of 3 years; in addition it had as chairman an independent scientist. The ACSP thus stood at Cabinet level as the supreme advisory body to Government in its efforts to formulate a coherent scientific policy. I discuss the nature of its work and achievements, as well as the problems which it has uncovered but has not solved, in a later section. Meanwhile I shall complete this review of the system by bringing you up to the present form of organization in so far as it can be detailed in the early phase of a new government's period of office.

The Trend Committee Report

During my somewhat lengthy period of office as chairman of ACSP certain deficiencies in our organization became increasingly evident to me. These arose primarily from the fact that since ACSP had simply been superimposed on the existing pattern of research councils, with the Atomic Energy Authority and the research and development activities of other ministries in the civil field (for example, in aviation) being outside its control, it was extremely difficult for it—or indeed for the Minister for Science—to exercise with any real authority the degree of control necessary if a scientific policy was to be implemented. There was, of course, no such thing as a budget for science; each of the organizations concerned made its own budget which it negotiated directly with the Treasury, so that it was at times well-nigh impossible for ACSP to control priorities. As a result of this unease the Prime Minister set up in 1962 a Committee of Enquiry into the Organisation of Civil Science, under the chairmanship of Sir Burke Trend. In its report, issued in 1963, the committee recommended a number of changes, of which the most important were these:

1) The division of DSIR into two bodies, one, the Science Research Council, to be concerned with the promotion of general scientific research and the other to be concerned with scientific and technological development in industry. Recognizing that this second body would be intimately concerned with industry and would thus in its operations differ somewhat from the research councils, the committee suggested for it the title Industrial Research and Development Authority and proposed that it should include the existing National Research Development Corporation as well as the industrial side of DSIR.

2) The creation of a new Natural Resources Research Council, which would include the Nature Conservancy together with fishery and general natural-resources research. The Medical and Agricultural research councils were to continue as before.

3) All these bodies were to be placed directly under the Minister for Science, who would thus carry the financial responsibility for civil science. He would be advised by a Council for Scientific Policy, which would have the same terms of reference as the former ACSP but would consist entirely of independent members and would be supported by a much stronger secretariat.

The findings of the Trend Committee were in substantial measure accepted by the Conservative Government in July 1964 but were not implemented because of the pending general election. The new Labor Government, which came to power in October 1964, has in fact also accepted the Trend proposals, with one modification: they have made the Industrial Research and Development Authority into a separate ministry—the Ministry of Technology. Opinions naturally differ as to the wisdom of this policy. On the one hand, the creation of a separate ministry may have an advantage in emphasizing the importance of technological development in industry, especially when the minister has, as now, cabinet rank. On the other hand, a separation of science and technology, with each of them under a different minister, is somewhat illogical and could complicate the development of a coherent scientific policy. It is pehaps too early to pass a final judgment, but the situation remains sufficiently fluid to permit of appropriate modification without great difficulty should experience prove this to be desirable.

Framework of the Organization

I apologize if I have seemed to dwell on the nature and history of British scientific organization at considerable length, but it was, I believe, necessary to do so since it differs radically from the United States pattern. In the United Kingdom civil science is financed throughout by the civil departments of Government, and very little research in universities is supported by defense departments. There is also very much less contract research carried out in universities and other educational institutions; in them research is supported, as far as science is concerned, partly through a general grant made by the Treasury through the University Grants Committee and partly by special grants from the research councils. Both types of support are given without strings, and there is no accountability to Parliament in either case. We believe that this system has great merits and, in particular, that it provides the maximum of freedom for scientific research in our universities. It has also weaknesses, of course. For example, under it, if Government wishes in the national interest to stimulate university research in some particular area of science, it may run into difficulty; a university may not be prepared to devote more of its general funds to that area and is quite likely to decline any money which is specifically earmarked for the purpose. But on the whole the system has worked tolerably well, at least in the natural sciences, although I myself believe that more extensive contract research might have given a much-needed stimulus to university engineering schools. Our organization of science in relation to defense is, rather naturally, more akin to the American organization, save that here too there is much less in the way of contract research farmed out to universities and private institutions. Since research in universities not only benefits greatly from the continued "throughput" of fresh young minds but also provides a stimulus and an attraction for able young people trying to decide on their career, it may well be that we in Britain could learn something from the United States in this respect, even if we would not wish wholly to adopt its system.

Science and the Educational System

Within the framework of the organization I have outlined, successive British governments advised by the Advisory Council on Scientific Policy have sought to work out and operate a scientific policy for the United Kingdom. A scientific policy is vital to us since, especially in a small country like ours with relatively few natural resources and an already overlarge population, it is on the strength of our science and technology that our economic future depends: we live on the success we can achieve in selling our goods in the highly competitive arena of international trade. But it is not so easy to formulate in detail a scientific policy, and it is still less easy to operate it successfully in a parliamentary democracy, a majority of whose citizens know little or nothing of science and are thus unaware of the extent to which it impinges on every aspect of national life. This is, of course, a problem in all countries, and at bottom it is educational. I do not say that all citizens of a democracy should be scientists, but they ought to have a better understanding than they now do of what science is, how it operates, and what its potentialities are.

For this, education is the only solution; science should form part of the education of every child, and it should be regarded as being as much a part of general culture as history or music or philosophy. This would seem self-evident and should be easy to achieve. But it has not proved to be so, especially in the settled communities of Britain and Western Europe in general. The social and political development of Europe from the time of the Renaissance was grounded largely on the classical civilizations of Greece and Rome, and these in turn shaped the general educational patterns. In them science had little or no place, and when the second industrial revolution began and the need for growing numbers of scientists and technologists began to make itself felt, the new and growing field of science was not readily assimilated into the educational system. One need only recall the foundation of the Technical High Schools of Central and Western Europe, which were created to provide trained scientists and technologists because the rigidity of existing universities prevented proper development of such training within them. It is interesting that in Britain the universities did, in the middle of the last century, accept the idea of technological studies, but since, in my opinion, they subsequently paid them little more than lip service, it might have been better for British technology had they refused and forced upon us the institution of technical universities.

It would be interesting, but would take too long, to discuss all the reasons for the quite inadequate integration of science into our educational system during the past hundred years, but it was perhaps bound to be a very slow process, since educational patterns are deeply rooted in social attitudes which change only very gradually in a settled community. The remarkable rise of the United States to industrial dominance and the even more recent emergence of Soviet Russia do, I think, support this point of view. There are two sets of conditions under which a flexible educational system geared toward modern needs can be obtained relatively easily. One set is the situation in which a civilization is developing in a new country with expanding frontiers and thus with no established traditions; this has been the case with the United States. The other, as exemplified by the Soviet Union, is a situation in which the entire fabric of society has been destroyed by violent revolution and a fresh start has to be made. In such cases the integration of science and technology into the social and educational systems is much easier (although it is not necessarily as well done as it ought to be in all cases), and I have little doubt but that this in part explains the rapid rise of America and Russia. But this does not mean that such integration cannot be achieved by others if they are prepared to make the effort. Surely it should not be too difficult to make science part of the education of every child. We must bear in mind that the function of a school education is to open a child's mind and not to stuff it full of specialized knowledge of one type or another. Specialization is, of course, necessary to provide professional skills, but it ought to come later at the stage of post-secondary education in the universities, technical institutions, and the like. This is the the line which we have been struggling to develop as part of our policy for scientific manpower. For we believe that only in this way can we produce the scientists, technologists, and technicians that we need today, together with the men and women specializing in other fields of activity who will have, in addition to their special knowledge, the awareness of science without which the modern world cannot be properly understood.

Technicians

There is one aspect of the scientific-manpower problem which has been giving me and others in Britain a good deal of concern and which I might mention specifically here because I suspect that it is, or soon will be, a matter of concern in every industrial country. It is regarded as self-evident that, if science-based technology is the mainspring of modern industrial progress, we need more scientists and technologists than we now have. For this reason we are well embarked on a program which will vastly increase the available number of university places in Britain. What does not always seem to be realized is that, if we are to translate the efforts of these scientists and technologists into practical results in industry, we will need many more technicians. Without them we will continue to waste a good deal of the time of fully trained scientists and technologists on performing operations which would be more appropriately, and probably better, performed by people with lower academic qualifications. Such misuse of highly qualified manpower is also socially dangerous since it will lead in time to frustration and political unrest. As yet, despite the existence in Britain of the technical colleges which developed from the mechanics institutions of the early 19th century, far too little has been done regarding methods of selecting and schemes of training technicians. Industrial training is still too heavily oriented toward the production of craftsmen, who will undoubtedly diminish in importance and number relative to technicians as industry gets more and more technically sophisticated. As I have said, this is a problem which is not by any means peculiar to Britain.

Problems in Common

When I originally agreed to discuss scientific policy in Britain I thought I might perhaps give you in the United States some new angles on the problems facing us in this field. But the more I considered things the more it became clear that not only the technician problem which I have mentioned but most other problems are in fact common to all of us. Repeatedly, over the years, I have been struck by the fact that when I had discussions with the chairman of the President's Science Advisory Committee in the United States he seemed to be worried about the same things I was. Perhaps the most intractable problems have been and remain those posed by the growing cost of scientific and technological work, at both the research and the development levels. This cost not only affects the permissible scale of effort in basic research in universities but also raises problems concerning the relationship of Government with industry: how best to deal with the problem of individual firms in the modern science-based industries who find certain types of project, which could lead to important innovation, beyond their private resources, and how to deal with the craft-based traditional industries which under present-day conditions tend to become more and more backward and inefficient.

That Government must spend money not only on technology but also on the support of science specifically oriented toward technology is clear. Government is and must be interested in technological progress, for upon it depends the wealth and power of the nation. This is, of course, most clearly seen in the field of defense, and let us remember that nearly two-thirds of the money provided by Government in the United Kingdom for research and development is spent through the Defence Budget (I believe the proportion in the United States is even higher). But the restriction of Government spending to those areas of science which are of immediate technological importance would be fatal. Pure science—the pursuit of knowledge for its own sake, untrammeled by other considerations—must be encouraged, for it is from it that the seeds of technological progress come, even if their germination is at times long delayed. And Government's support of pure science must be disinterested, for indeed it should in some measure stand to pure science in the role of patron just as it does to music and the arts, even if, in the last analysis, the role contains an element of self-interest.

All this is self-evident, and indeed the action of governments in most advanced countries shows that the general thesis has been accepted; scientific research in universities has been supported, and government aid has been applied to support technological development both in defense and in civil industry. In the past it was, of course, rather easy to do this, and until after World War II it was relatively painless from a governmental standpoint. For the scale of activity was comparatively small and the overall cost negligible as a fraction of the national budget. But times have changed; as science and technology have progressed, so their demands on national resources have grown, and quite clearly there is a limit to what society is prepared to devote to them. No country's national resources are unlimited, and there are many conflicting calls upon them. The scientist must recognize that he represents only one element in society and that he cannot be given a wholly free hand as regards expenditure, any more than any other element in society can.

Parallel Patterns of Expenditure

Expenditure on research and development in the United Kingdom has increased about tenfold during the period since ACSP was formed 17 years ago, and at its present rate of increase would double every 5 years. The parallelism between the United Kingdom and the United States is striking in this respect. In 1961–62, the last year for which full figures are available, the United Kingdom spent 2.7 percent of its gross national product on research and development; the corresponding figure for the United States was 2.89 percent. When allowance is made for some differences in methods of calculation, the percentages can be regarded as nearly identical. Equally interesting is the fact that expenditure on research and development in the two countries has been rising during the past 5 years at about 15 percent per annum, while the supply of scientific manpower has increased at an average rate of about 5 percent in the United Kingdom and 6 percent in the United States. No other country devotes anything near this percentage of its gross national product to research and development. The patterns in the two countries are surprisingly similar, although naturally, since the United States has three times the population and eight times the gross national product of the United Kingdom, the difference in absolute amounts of money is large. It is this difference in absolute figures, of course, which makes America appear to many people in the United Kingdom so openhanded in its support of science. To match these absolute figures we in the United Kingdom would have to devote more than 7 percent of our gross national product to research and development.

Priorities

Now I think that the United Kingdom is still spending too little on research and development but, on the basis of a very rough analogy between the nation and a vast and diversified industrial complex, I would regard such a figure as 7 percent of the gross national product as being almost certainly too high. It is, of course, impossible to lay down a definite proportion of the gross national product which a country should spend on science and technology. What we must do is to decide how much we need to spend and in what ways, taking into account our available resources in money and manpower, the other demands upon them, and the likely return on our investment. Here scientific and economic policy come together, for the only way in which we can spend more money is by increasing our gross national product, and to do this the distribution of our scientific and technological effort must be planned to provide the maximum stimulus to our economic advancement.

This is why linkage of scientific policy to economic policy is now supremely important to Britain. We cannot afford to operate on a competitive scale with all other countries in all areas of science and technology. Nor should we attempt to do so, for if we do we will spread our limited resources too widely and in the end achieve nothing. We need to examine carefully our whole industrial structure and establish priorities. We must decide on the type of industry on which we should concentrate our effort (I believe it should be that which has a high content of technological skill), establish priorities, and set our policy accordingly. Equally, we must face up to the need to set priorities in the field of pure science, where, for example, in such areas as nuclear physics, space, and radioastronomy costs are nowadays becoming large; in the first two of these areas the need for international collaboration to meet the large expenditures involved has already been recognized by the formation of CERN and ESRO (European Space Research Organization) in Europe.

Now I know there are people who say it is impossible to establish such priorities, especially in the field of scientific research. It is claimed that, since the essence of pure scientific research is its unpredictability, any attempt at selection would be wrong even if it were possible to make a meaningful comparison between, say, research in nuclear physics and cancer research. Now I do not retreat in any way from my expressed view that science must have freedom to develop and that to harness it wholly to technological ends would finally spell disaster. But this does not mean that we should not apply some discrimination in deciding in which areas of science we should mount a major effort. If, for example, we spend vast sums of money in going to higher and higher energies in nuclear physics we must ask ourselves whether we may be putting too high a proportion of our best scientific manpower into the pursuit of what is, after all, only one of many fields of science. Again, is it better to spend the available money this way than to promote studies which might lead more directly to the opening up of vast new fields of technology—for example, in the area of direct generation of electrical power? These are questions which we in Britain must ask ourselves. They are not easy questions and it is very difficult to answer them; but an answer must be found, and I believe that the necessary criteria for making such hard choices are already available.

As I have said, we face this problem in Britain now; it has indeed been with us for some time past, but now we can no longer evade it. But the same problem looms up also in America, and there are clear signs of concern about it. At present both countries are probably spending around 3 percent of their gross national product on research and development, and that expenditure is at present increasing at about 15 percent per annum. This rate is far above the rate of increase of the gross national product, and quite clearly we cannot go on increasing research and development indefinitely at 15 percent per annum; if we did, it would absorb the entire national income by about the year 2000. Since there is no evidence that I know of to indicate a slowing down in the rate of advance or in the rising cost of research and development, it is clear that sheer economics will force upon all of us the need to establish priorities and make deliberate choices in science.

There are many other aspects of scientific policy in Britain which could be discussed, but it is perhaps best to leave matters on this note. For the central issue of scientific policy in Britain, as in all other countries at the present time, comes down simply to this question of determining in the light of a country's resources in money and manpower the priorities in science and technology that are essential if its economic future is to be assured. And in the long run the enormity of this problem, coupled with the essentially supranational character of science and technology, may help to hasten the day when the old and often bitter national rivalries may be overcome, and science, with its immense potentialities for good, may serve as the cement which will bind together all mankind.

Note

1. Until 1956 DSIR, which, unlike the other research councils, had the structural pattern of a government department, operated with an advisory rather than an executive council, but this made little real difference in its operation.

News and Comment

Congress: A Higher Education Bill Is Considered a Likely Prospect, But Hard Bargaining Lies Ahead

Before Congress decamped for the 4th of July recess the House Education and Labor Committee did everything but take one final formal step to report a higher-education aid bill which in several important ways is a companion piece to the elementary- and secondary-education act passed earlier in the year.

The new House bill, in one main section, puts emphasis on programs to help solve urban problems, and in another provides a precedent-shattering sort of aid to students in "exceptional financial need." These and several other features make the bill—along with the elementary- and secondary-education act, the poverty program, and the Appalachia act—fit squarely into the category of "Great Society" legislation.

Like the school-aid measure, the new bill is an artfully compounded legislative ragout calculated to please different palates. A loan-insurance and interest-subsidy plan in the bill is meant to endear it to the middle class. And a program of grants and fellowships to bolster "developing institutions" should help assuage some of the mounting resentment in Congress and back home on behalf of those colleges and universities which have remained on the outside looking in at the feast of federal support of scientific research.

The House version builds on the administration bill (H.R. 3220) introduced in February. But, while the new bill preserves the spirit of the original, it considerably alters the letter. In addition, committee changes have resulted in estimated costs for fiscal 1966 being more than double the total of $250,000 called for in the original.

So extensive are the changes that a "clean bill" was deamed necessary. This means that a new bill had to be introduced and passed by the committee. This had not been done when Congress recessed on 1 July, but close observers saw no hitches developing to prevent reporting of the bill; this would send it to the Rules Committee and thence to the floor.

In the Senate, the education subcommittee of the Committee on Labor and Public Welfare this week was meeting in executive session to "mark up" its own version of higher-education legislation. While the House committee devoted itself to making extensive changes in the bill, the senators, it is understood, are disposed to add several totally new sections.

On the House side, the title on financial aid to students was the most controversial part of the measure within the committee, as it is likely to be outside it. Scholarships have been the perennial hot potato of higher-education legislation, and the subject of financial aid was the chief cause of a delay of more than a month in committee action on the bill.

At one point the idea of federal scholarships for undergraduates on any terms was dropped. A compromise was reached, however, reportedly in part