THE ALLOCATION OF SCIENTIFIC RESEARCH TO THE UNIVERSITIES.

By PROF. H. J. BHABHA, *F.R.S.*

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It has fallen to me today to talk about the organisation of scientific research in the universities. It is impossible, in the short time at my disposal, to go into the matter in any great detail, but I would like to bring out certain broad principles.

It is customary to divide research work into two categories, pure research, and applied or technical research. This division is a matter of convenience and may usefully continue to be made. It is, however, most important to realise that this division does not carry with it the least implication of the relative usefulness, or practical benefit to mankind of the two categories of research. This point cannot be overemphasised since the contrary view still prevails among many influential men in government and industry in India, despite the fact that it has been long abandoned in progressive countries like Great Britain, the United States of America and the U.S.S.R. Even a cursory glance at the history of such an intensely practical and useful invention as wireless proves this point in a striking manner. The discovery of wireless waves by Hertz, on which the subsequent development of wireless is based, was not a matter of chance, but was the result of a deliberate search for waves whose existence had been predicted by theory. The electromagnetic nature of light had been demonstrated by the experiments of Faraday, and it was the attempt to explain this and the other known facts about electricity which lead Maxwell to formulate his famous equations and the electromagnetic theory of light. It was at once clear from the equations that electromagnetic waves of wavelength millions of times greater than that of light and of a correspondingly lower frequency must exist, and it was natural to try and detect the emission of these waves when a condensor is discharged, after Kelvin had shown this to be an oscillating phenomenon. I think it is fair to say that Hertz's detection of wireless waves and the whole subsequent development of wireless would have been retarded by several decades but for the previous 'pure' research of Faraday and Maxwell. This example brings out clearly that pure and applied research are but two stages in the historical development from ignorance, through knowledge, to control, of the phenomena of nature in any given field. There is, therefore, no question of differences in practical importance between the two categories of research. One should rather look upon 'pure' research as long term research, while technical research, being historically the later stage in any line of development, may be looked on as short term research.

I have tried to establish this distinction between the two since it determines which type of research is best allocated to the universities and which to those technical institutes which are in direct touch with industry. Long range research would appear in general best carried out in the universities or in special institutes attached to the universities, *since while the research is in progress, its development and trend should be entirely unhampered by any thought of immediate utility.* It is precisely in this way that knowledge of the domain of nature concerned can be most rapidly accumulated, leading to the subsequent practical applications in the shortest possible time. Moreover, the best universities *should* have, to a large extent, the staff necessary for the work, and vice versa, the staff necessary for pure research is in general suitable for teaching the wide subjects which are normally taught in universities. But such a programme would need a very widespread revision of our university system in India, where with a few exceptions, research facilities are very inadequate, and the staff overburdened with teaching duties.

The pure or long range research which should be allocated to the universities should have the widest possible range. It should include on the one hand research in all branches of 'pure' mathematics, which, as the last century has shown, have turned out to be of the most unexpected importance in formulating the laws of nature and in solving practical

problems. Research on subjects where the applications are still so remote that it is impossible even to foresee them are clearly best carried out in the universities. At the other extreme it should include problems of a practical nature but requiring long term planning of research, as for example the development of the technique for using nuclear energy for power production, the solution of which would have the greatest practical importance to industry in the future and may well change the whole basis of it. Large sums are already being expended on this problem in Great Britain and the United States of America and doubtless also in other countries, but naturally under conditions of great secrecy for security reasons. I have mentioned this problem because it lies midway between the ordinary pure research problem and the technical problem. It is a problem the solution of which would have vast and immediately foreseeable applications in all branches of industry, and yet it is one which requires the long range planning of research over a period of at least a decade and the development of entirely new ideas and a new technique.

There are, on the other hand, technical and development problems which crop up continuously as an industry develops, and which are capable of more or less immediate solution. Such problems are clearly best dealt with in the research institutes directly attached to or closely connected with the industry concerned, and they would, on the whole, be unsuited for being dealt with in the universities.

There is, however, one important point which must be mentioned. Scientific research is very poorly financed in India and even a tenfold increase of the present expenditure would leave India far behind the other progressive countries of the world. In these circumstances, *it would clearly be best to concentrate the large research departments in a few big universities,* for to spread them over all would merely result in inadequacy of financial means for all. Moreover, most of the universities in India have inadequate staff and equipment to carry on any big research. Even if money is found for equipment, a highly trained and gifted staff cannot be created in less than a decade. Such universities may well be allowed to tackle development and technical problems.

It is clear from the above considerations that no country, which wishes to play a leading part in the world, can afford to neglect pure or long term research, for it is precisely on this research that depend the developments in industry and public economy which are likely to take place, say, twenty-five years hence. This fact should always be borne in mind when money is allocated for research. This principle has been fully accepted by the extremely practical and efficient administrators who are responsible for the government of the Soviet Union today. They do not draw a line between 'pure' and 'technical' research and they believe that 'there is no genuine knowledge of the universe that is not potentially useful for man, not merely in the sense that action may one day be taken on it but also in the fact that every new knowledge necessarily affects the way in which we hold all the rest of our stock'. Although there is no country in which science and industry are so closely linked together as in the Soviet Union, yet it is for this reason that the most liberal support is given to 'pure science' and the Physico-Mathematical Institute, which is supposed to carry out theoretical research only, and which, we read, 'continued its investigations of quantum electro-dynamics, and *prepared the way for the experimental* study of the structure of matter. (The disintegration of the atomic nucleus)'. The great successes of the U.S.S.R. in the economic, social and military fields are due to this enlightened policy and India would do well to follow it.