THE NEED OF SCIENTIFIC AND TECHNICAL MAN-POWER FOR ECONOMIC DEVELOPMENT*

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1. Four years ago All-India Radio gave me an opportunity of speaking on problems of National Planning. I am glad, again, to have an opportunity of saying a few words regarding one important, perhaps the *most* important, aspect of economic development, namely, the need of expanding our scientific and technical man-power.

2. The object of economic development is the improvement of the level of living of forty crores of our countrymen. This means having a bigger and bigger supply of food, clothes, housing, and such other things, and greater facilities for medical care, education, and cultural amenities. That is, having more and more of what economists call consumer goods and services. Our aim then must be to increase continually the production of consumer goods.

3. How can this be done ? To some extent by using traditional methods of production such as weaving and handicrafts and by employing idle hands to the fullest possible extent. This would give employment to millions of our countrymen who are sitting idle for the whole or a good part of the day for lack of gainful work. But this can go only a part of the way.

4. To increase production in a really big way we must use machinery. For more than a hundred years we have been manufacturing cloth in textile factories. Where did we get the machinery for this purpose ? We have been mostly importing them from abroad. Why ? Because we did not have factories to produce machinery. This brings us to the heart of the problem.

5. Machinery is made of steel, metals and raw materials. The cost of such raw materials is small, and often only ten or fifteen per cent of the price we pay to purchase the machinery from abroad. If we use our own steel and raw materials and make the machinery ourselves, we can have very much more than what we can purchase from abroad. Obviously, then we must set up factories to manufacture heavy machinery and heavy electrical and other equipment.

6. Until the beginning of the Second Five Year Plan in 1956 we had not given enough attention to this aspect of our problem. Fortunately, it is now being appreciated that we must ourselves manufacture as much machinery as possible.

7. We shall require steel for this purpose. But we have large reserves of high quality iron ore in India, and we can make more and more steel, and use this steel to make more machinery and produce more electricity to drive the machinery. That is, we must produce more and more of what are called "capital goods". This is the second level.

* Based on a talk broadcast from All-India Radio on 23 September 1959, with supplementary notes.

8. However, it is only with the help of engineers, technologists, technicians and skilled workers that raw materials can be converted into machinery and electricity and power; and can then be used for the production of consumer goods. We must then have a larger and larger supply of engineers and technical personnel in future. This then is the third level.

9. We have to go a little deeper. Natural resources are not identical everywhere. There are wide variations from one country to another. It is essential that we should make the best use of what we have in our own country. We can find out how this can be done only through scientific and technological research. We must continually expand research of this type, which is called applied research, in which use is made of basic scientific knowledge to solve practical problems.

10. We cannot stop even here. We have to go one step further. Applied research can use only whatever basic scientific knowledge happens to be available. But we can increase such knowledge through, what is called, fundamental or basic research. The more we do this, the greater will be the possibilities of applied research. The most dramatic example is atomic energy. The possibility of utilising the energy of the atom had first emerged from abstract theoretical developments of physics. It has now thrown open a new vista of technological progress for humanity. We must continually expand both applied and basic research. This is the fourth level.

11. We thus have to think of four levels. First, to increase the supply of consumer goods which, so to say, is at the top or the first level. To do this, we must expand the production of capital goods; this is the second level. Both of these will require a larger and larger supply of engineers, technologists, and technical personnel; this is the third level. Engineering and technological developments would call for an increasing volume of applied research. But applied research requires a sound foundation of basic research. We must have an increasing supply of research scientists of ability. Unfortunately, their number is small in every country. We must try to make the best use of *all* whom we can discover. This is the fourth level.

12. Now consider the factor of time. We can set up factories for consumer goods very quickly; in a year or two, if we use imported machinery. To develop the production of capital goods would take more time, from five to ten years, at least. To secure an adequate supply of engineering and technical personnel would require still more time. And, finally, we must have enough scientists of ability for both applied and basic research which would take at least a generation. This is the *four*-fold logic of economic development.

13. How to attract and hold a sufficient number of able persons in science and technology is then the crucial problem of national development. This can be done only through a proper social appreciation of science and scientists, which is the fifth and deepest level of the problem.

14. I have been speaking so far at a somewhat abstract level. Let us consider the historical evidence. The level of living in Europe was probably about the same as in India two or three hundred years ago. There is some evidence to suggest, that, for the vast masses of our countrymen, the level of living has not changed very much since the time of Akbar.

15. There has been, however, a revolutionary progress in Europe and America. This was possible only through the use of machinery driven by steam or electricity instead of by human or animal labour, that is, through the progress of science and technology. The British had first developed the modern way of making steel. Germany started later but, through research, developed more efficient methods. America, through more research, increased the efficiency. More recently, Russia, has gone further ahead with the help of still more research.

16. It will be instructive to make some comparisons between the two giants, USA and USSR. America has attained the highest level of living and has the largest supply of consumer goods in the whole world. Russia is still very much behind, especially in luxuries like butter, chocolates, nylon and such other things.

17. In capital goods, on the other hand, the gap is smaller. Russia is already producing roughly half the steel which America can produce. In heavy machine building, for example, to manufacture machinery to erect new factories for steel, USSR has probably gone ahead and can expand the production of steel faster than USA. It is only a question of time before Russia can catch up with America.

18. Next consider the third level of engineers and technical personnel. Here USSR has gone indisputably ahead of USA. In 1957 America had approximately six and a half lakhs of engineers while Russia had nearly eight lakhs.[1] In the same year, 71,000 engineers had graduated in Russia against about 40,000 in America.[2] Russia already has a larger number of engineers, in absolute numbers as well as on a population basis, and yet Russia is increasing the number at a fast rate. In fact, Russia is training, every year, more engineers than all the other countries of the world, including USA, taken together.

19. We can also learn much from the Americans who have quickly noted the Russian developments in science and technology; and are making better arrangements for the teaching of science, providing more funds for scientific research, and improving the conditions of work for scientists. Similar changes are also occurring in the United Kingdom and other European countries.

20. All this, I think, has an important lesson for us. We have a very low level of living. It is not possible to improve it rapidly by increasing the production of consumer goods with the help of imported machinery. We did try to do this for sixty or seventy years or more and failed. We must first increase, very rapidly, the production of steel, electricity, heavy machinery, and other basic industries. The only way to do this is to increase the supply of scientific and technical manpower. This must be given the highest priority. This is the only secret of the spectacular progress of Europe and America, and now of Russia.

21. Europe and America, and now Russia, have become great by their acceptances of science. Social appreciation has given confidence and encouragement to the scientists. In Russia research scientists have the highest pay and enjoy great social prestige. The President of the Soviet Academy of Sciences gets the highest salary

[1] Number of engineers in 1957 in USA, 6,37,000 and in USSR, 7,93,000.

[2] In India the estimated number of engineers in 1955 was 72,000 out of which 31,000 were university graduates and 41,000 diploma holders.

in the whole country, higher than that of the Soviet Prime Minister or the President of the USSR. This, of course, is only a gesture but it has a deep social significance.

22. This brings me to the fifth level. In India also we used to have a great tradition of respect for the Brahmin, pre-eminently as a teacher. The old tradition has lost its values and must go. And it is necessary to build up a new tradition of social appreciation of science and scientists.

23. We have made some progress since independence. The number of educational institutions has doubled. The number passing the Matriculation examination[3] increased four times in eight years between 1947–48 and 1955–56. Enrolment of students, at the intermediate and university levels[4], nearly doubled in six years between 1950–51 and 1956–57. Enrolment of engineering students, at the degree and diploma levels, rose from about 15,000 in 1955-56 to 31,000 in 1958-59 or had doubled in three years. Over 16,000 persons were awarded the master's or equivalent degree in science, after independence, out of a total outturn of 32,000. That is, we produced more scientists after independence than during the whole previous period. Expenditure on scientific research has increased, perhaps, seven or eight times.

24. The advance in education after independence has been greater in many ways than total achievements during the whole of the British period. This is encouraging but not enough. Some of the improvements are still on the surface. Educated persons are not being fully utilized. The educational base still remains narrow and there are greater disparities in opportunities. The quality and depth of education and scientific research have not been improving satisfactorily.

25. There is urgent need of a deeper understanding of the scientific revolution which has opened new paths for human civilization. The content of science changes every day. The spirit of enquiry and the search for truth give it its enduring values.

26. Scientists cannot possibly take the place of political leaders or administrators. It is not desirable that they should do this. What is necessary is that scientists should have the initiative and freedom of action in matters which have concern with science and technology.

27. The scientific revolution has no conflict with art, literature, music and such other things in which values do not change with time. Knowledge as such, either of classical languages or of science, is not culture. The scientist also must acquire wisdom and appreciation of human values.

28. India is fortunate in having a Prime Minister who has a full appreciation of human values and who takes a keen personal interest in science and technology. But, what he or Government can do ultimately depends on public opinion. The most basic need is for the general public to appreciate the role of science in the modern world. This is the deepest issue before us.

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[3] Actual numbers were : 1,16,680 (1947–48); 1,61,955 (1948–49); and 4,29,494 (1955–56).

[4] In 1950–51 about 3,99,500 and in 1956–57 about 7,68,000.