ORGANISATION OF SCIENTIFIC RESEARCH IN THE U.S.S.R.

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I. Scientific Research organised on the Principle of 'Unity of Theory and Practice'.

Scientific work in the U.S.S.R. is characterised by its subjection to a unified rational plan. The very idea of planning in regard to scientific work in general, and Scientific Research in particular, has very often appeared to be utopian. The real function of science, however, in the complex process of social life, is the function of widening and deepening the practical work and increasing its efficacy. Historically, all the sciences grew out of practice, being indeed but the rationalisation of it, a fact which will be confirmed by any book on the history of natural science. The formation of the basic principles of thermodynamics came as the result of the universal spread of steam-engines, which prompted research workers to deal with a number of cognate questions. The same with electrodynamics. If electricity had not played a great rôle in industry by the end of the nineteenth century, we should have had no theory whatever on electrical phenomena. The possession of any accurate and systematic scientific knowledge on electricity owes its origin to the development of electrotechnics. On the above considerations are based the measures of the Soviet Government for the organisation of the net-work of Scientific Research Establishments, the guiding principle being expressed by the slogan of 'Unity in Theory and Practice'. Theoretical problems are raised and solved in connection with general practical problems and vice versa (viz.) the solutions of practical problems are illuminated by theory. Hence, the decision of the U.S.S.R. to bring the scientific research establishments close to industry and to work out for them a plan of activity answering the needs of the industry. The lack of cohesion in scientific work in the last two centuries, led to extreme differentiation and specialisation of research work, the natural result of which was the sharp separation of 'academic' University science from current social problems. Isolated, quiet 'academic' laboratories and cabinets with their semiartisan individualistic forms of work, cannot harmonise with the modern organisational and economic forms of big industry. Lone investigations must give way to the great collective establishments for scientific research. The U.S.S.R. never lost sight of the above facts.

Economic growth and economic independence of the Soviet Union demanded the solution of a number of technical problems, while in its turn the solving of these problems compels the raising of a whole series of important theoretical scientific problems. This is amply evidenced by the facts that the development of socialist agriculture has forwarded the development of genetics and of biological sciences generally, and that the exceptional requirements for the study of the natural resources of the U.S.S.R. led to extensive geological works and advanced geology, geophysics, geo-chemistry, etc. These facts are obviously quite sufficient for rejecting the notion that the recognition of the practical function of science implies the limitation of its scope and the lowering of its tasks. 'Great practice calls for great theory'.

II. Problems and Planning of Scientific Work.

The plan of scientific work in the U.S.S.R. is determined in the first place by the technico-economic plan by a clear perspective of technical and economic development, which means not only a synthesis of science, but also a *social* synthesis of science and practice. 'The relative separation between theory and practice is eliminated and also the defecation of science itself. Science reached the pinnacle of its social self-consciousness' in the U.S.S.R.

The U.S.S.R. had to face the following main groups of problems connected with technical reconstruction:—

(1) Prospecting for natural wealth, both of known deposits, and of previously unknown sources, which presupposes the development of geology, geophysics, geochemistry, biophysics, biochemistry, botany, zoology, etc., and consequently of physics, chemistry and biology.

(2) Finding the best methods of utilisation of already known natural resources of the country which involves the study of their structural properties and consequently that of a series of complex problems in physics, chemistry, etc.

(3) Production of the best means (machines, apparatus, etc.) of such utilisation needs the development of mechanics and physics. And the three taken together imply a wide development of the mathematical sciences.

(4) Devising the best form of organisation for such utilisation (complex production). The problem of complex production demands serious theoretical work on problems of contact existing between different sciences.

(5) The rationalisation of production which depends upon the study of a whole series of technical, economical and physiological questions and lends an impetus to the organisation of corresponding researches.

(6) The working man as the subject of the process of labour; and this necessitates research in physiology and psychology.

The solving of these problems presupposes the development of all branches of both natural and social sciences. Any plan of economic and technical reconstruction should include the plan of scientific research work. Science should also be planned. Today the 'academic studio' has been supplanted by the huge laboratories and the lone scientist by huge scientific organisations. How can the life of a big laboratory be organised without an internal plan? How can the work of the group be built and a programme of themes and problems be drawn up without some preliminary plan? And if a plan is essential for the organisation of the internal life of the laboratory why should not such a plan be built upon a social scale? The modern scientist understands that the more numerous the experiments and thoughts upon a given subject, the greater is the likelihood of arriving at a solution of scientific problems. The adoption of the principle of planning no doubt implies a certain amount of restriction, but every one will agree that the solution of scientific problems can be obtained quicker by planned attack from various aspects than by unorganised individual grappling. Of course, the plan must be good. 'Only in the collectivity does the individual obtain the means which make possible the thorough development of his talents; consequently, personal freedom is possible only in the collectivity.'

The Soviet Government came to the decision that if they must overtake and even surpass both technically and economically the advanced capitalist countries, the net-work of scientific research institutions should grow even more rapidly than the most rapidly growing main branches of the heavy industry, and considerably more rapidly than the corresponding net-work of Institutions in Western Europe and America.

The planning of thematics (with regard to themes for research) is naturally determined by problems of the adaptation of scientific research work to the needs of economic reconstruction and can be built solely upon the basis of concrete technico-economic plans. It should embrace problems demanding immediate solution (arising from economic set-backs or difficulties encountered today), problems connected with the carrying out of current economic plans, problems arising out of perspective plans and problems of tomorrow. Not one of these four types should be omitted. They must be linked together in some fashion. Very often, in scientific work as in industry, it may be necessary to raise simultaneously the current problems of today and the perspective problems of 'tomorrow'. A rational system would, therefore, entail here also the apportionment in space for apportionment in time, as in Industry. This had to be carried out through the system of 'Head' and 'Branch' Institutes and Factory Laboratories. The planning of themes presupposes the solving of the problem of rational apportionment of these themes among the different research establishments. Mutual competition and secrecy as is evidenced today become

replaced by mutual information and joint elaboration of general plans by allied scientific establishments, resulting into a system of utilising various methods of solving one and the same problem. The planning of construction and means becomes the product of the planning of thematics.

On the other hand, the planning of scientific forces has tremendous importance. The problem of supplying qualified workers is of exceptional magnitude. Vast reconstruction needs hundreds of thousands of qualified people. Their numbers have to be fixed in relation to thematics and the time for their training too. Then comes the problem of their distribution according to different branches of themes of scientific research work, as well as of securing the requisite qualification of such workers. And finally comes the problem of securing a sufficient influx of reinforcements for all degrees of scientific qualification. Naturally, all the problems enumerated above are inter-connected forming an organic whole. They are functional parts of the single plan of scientific work which, in its turn, forms a functional part of the general National Plan.

III. Types of Scientific Research Institutes.

Experience has led to the necessity of establishing three basic types :—

(*a*) Subsidiary points, (*b*) Branch Institutes, and (*c*) Head Institutes.

(*a*) The network of subsidiary points serves the direct interests of the respective industrial enterprises (factories, mills, mines, farms, hospitals, etc.). The activity of this network is not the simple fulfilment of elementary technical tasks connected with production (analytical work, examination of quality, etc.), but includes the elaboration of new methods, improvement of old methods, construction of improved models, etc. These subsidiary points form an integral part of (*b*) the Branch Institutes.

(*b*) The Branch Institutes are required to serve the interests of entire branches of industry, agriculture, etc., and carry out direct tasks given to them by the industrial organisations. They do not *necessarily* limit themselves to this activity. They raise, on their part, a series of prospective problems of more general and profound importance, growing into theoretical problems of a fundamental character. In this sphere of activity they keep in contact with the Head Institutes.

(*c*) The Head Institutes solve the more general scientific questions arising from the whole complexity of the techno-economic plans. These again do not limit themselves to the above activity, but they also raise and elaborate the great fundamental problems of science, 'problems of tomorrow'.

Such is the line of connection, traced from bottom up. The return road is also perfectly clear. The Head Institutes advise the Branch Institutes and help them in solving problems. The technical results of problems handled by the Head Institutes are passed on to the Branch Institutes for detailed technological treatment. The Branch Institutes, in their turn advise the subsidiary points through whom they carry out the adoption of new technical methods and improved models in industry. Thus there is created a rational form of subdivision of labour between different categories of research institutes, assuring certain unity between the theoretical and applied problems of scientific work. Experience has shown that such a form of organisation, securing correct relationship between general problems and the problems of today, is wholly successful.

The connection of scientific research Institutes with industry is effected as per above and is regulated by plan, thus securing the carrying out of the unification of theory and practice. Today, science has become the 'all-pervading principle' in the U.S.S.R. as was urged by Lenin. The gigantic growth of the scientific institutions of the Soviet Union, both quantitatively and qualitatively, demonstrates that the fear of the debasing of science to result from deliberate association of science with industry, is utterly unfounded. On the contrary, in this association we justly see the augury of rapid and successful development of scientific activity.

IV. Research Institutions, their Working and Achievements.

Before this war the number of large research Institutes was about 80. The network of Agricultural Institutes connected with the Lenin Agricultural Academy includes almost 50 establishments. The Research Institutes of the Commissariat for Public Health number nearly 30. Over 40 Institutes are maintained by the People's Commissariat of Education; over 10 Institutes are maintained by the People's Commissariat of Ways and Communications. The people's Commissariat of Heavy Industry alone has 126 units with 163 branches, besides the network of Factory Laboratories. Over and above these, whole networks of Institutes are incorporated in the Academy of Sciences, in the Communist Academy, etc. Closely connected with these large institutes is a wide network of subsidiary scientific research Institutions. There were already upwards of 800 large factory laboratories. Adding to these figures the Zonal Experimental Stations, the different local branches of the great establishments, etc., the total number of scientific research points reaches well over several thousands, besides laboratories attached to higher schools technicians, museums, etc.

I visited the University Laboratories and Laboratories of Technical Institutes of University Grade and Laboratories attached to Factories, etc., in Moscow, Leningrad, Kharkov, Rostov, Dnipropetrovsk, Tiflis, Erivan and Baku, besides sixteen Head Institutes.

It will be easier to get a picture of the inner working of these Institutes by taking a concrete example, say the Lenin All-Union Academy of Agriculture presided over by that brilliant scientist and academician Prof. N. I. Vavilov, whom I contacted so happily. Some of the best scientists working in specific Institutes may happen to be members of the Academy of Sciences, as also in charge of specific academies for special studies, of which the All-Union Lenin Academy of Agriculture, with an annual research grant of 100,000,000 roubles, is an example. This Academy has 14 big Institutes besides some 70 branch Institutes under it, whose work it co-ordinates and controls.

The Institute of Animal Husbandry (one of the above Institutes) has, in its turn, 15 departments and controls some 150 sub-stations spread over the Soviet Union. Special research work is carried on at the Central Institute of Animal Husbandry in theoretical problems and the main practical problems of fundamental importance. The sub-stations (150) engaged themselves in local problems and the work in the local problems is co-ordinated at the Central Institute. The sub-stations collect data after putting into practice the applications of the researches carried out at the Central Institute. These data are then sifted and generalised. Thus, the Central Institute always looks ahead for future work and the importance of such work to the Soviet Union. The annual budget of the Central Institute is 4,000,000 roubles. The same holds true about the remaining of the above-mentioned big Institutes. As regards the achievements of the scientists under the Soviets, they are too numerous to be mentioned. Some of the practical ones may, however, be mentioned.

V. Training of New Scientific Forces.

The 900 Technical Institutes and Technicums and 400 Universities supply a constant flow of artisans, technicians, technical foremen and engineers as well as trained industrial workers of all classes. For want of time, I must confine my attention to the supply of trained research workers only. The Academy of Sciences is directly responsible for the major portion of highly trained research workers, trained directly under the Academicians and Professors who are, as a rule, consultants to one or more factories also. These Academicians and Professors collaborate with 'Aspirants' in their research work. The Aspirant receives a stipend of from 250 to 300 roubles per month. The best of the Higher School (University) men are selected as 'Aspirants'. Under the newly revised system, the Aspirant must establish touch with industry in the *first two* years of his work also remaining in touch with his Professor. During the third year he goes through a course of advanced study in the special branch in which he is taking up research work and also in allied subjects

like mathematics, foreign languages, etc. Then he undertakes a specific problem of research involving some technical problem demanding solution in practice or a practical problem awaiting solution, under the guidance of his Professor. He submits a dissertation of his results and gets his Master's or Doctor's degree after *at least* two years of research work. If he chooses to be a professor, he works as an assistant, then as a teacher and after his Doctorate he can wait for a Professorship. The Doctorate is usually obtained by working for from 7 to 10 years after graduation and it is only conferred by the Academy of Sciences and a few special Institutions like the Institute of Energetics.

VI. The Academy of Sciences—the Centre.

The Academy of Sciences is the centre of scientific activity, which synthesises the co-ordination of work going on in the Soviet Institutions, Laboratories, Experimental Stations, Commissions and Museums. The Academy bases its work upon the principle of the utmost appreciation of scientific theory to the practical tasks of socialist reconstruction. The problems are classed as under:—

(1) The complex of problems relating to the study of the structure of matter based on the latest achievements in astronomy, physics, chemical physics and chemistry.
(2) The group of problems relating to the study and utilisation of the natural resources of the Soviet Union.
(3) Problems connected with the systematic investigation of the power resources of the Soviet Union, including distant power transmission and electrification of industry, transport and agriculture.
(4) Group of problems relating to the new construction carried on throughout the Soviet Union, with questions of distribution of the productive forces, seismic investigations, investigation of building materials, questions of health protection, etc.
(5) Group of problems connected with chemification of the country.
(6) The complex of problems relating to the evolution of the organic world for the stimulation of great harvests, fight against draught, cultivation of new crops, intensification of cattle raising, etc.
(7) The complex socio-historical problems connected with the task of the overcoming of capitalism, etc.

In virtue of a special Statute approved by the Soviet Government in 1930, the U.S.S.R. Academy of Sciences in Leningrad constitutes the highest Research Institution in the Soviet Union. It set itself the task 'to study the country's productive forces and contribute to their utilisation', and 'to elaborate the methods of applying the scientific theories and the results of scientific experiments and observations to the tasks of Socialist construction in the U.S.S.R.'. A special Council was created within the Academy for general guidance in planning the expeditionary and research activities of the different Institutes and the other establishments of the Academy. As a result of the expeditionary activity of the All-Union Academy, e.g. of its work in the field of geological prospecting, of exploration of both ore and non-ore minerals, for coal and petroleum, the whole map of the natural resources of the Soviet Union has changed, and new and great possibilities opened up for industrial construction. In recent years each Session of the Academy bore the character of scientific contributions to one or another branch of the country's economic life.

The Academy of Sciences plans its activities for the year in close co-ordination with the planning of economic reconstruction by the Soviet State. Being the leading centre of scientific work of the Soviet Union, the Academy undertakes the elaboration in all the branches of knowledge of the central theoretical problems raised by the Socialist reconstruction. It also endeavours to co-ordinate its work with that of other scientific establishments and Institutes, e.g. Department of Social Sciences, the Institute of Economics in co-operation with which, it helps the State Planning Commission. Through the Agrarian Institute and the Institute of Economics, both of which are under the Communist Academy,

it helps the Lenin All-Union Academy of Agriculture which does the synthesis and collaboration of all plans of work for agriculture, under the People's Commissariat of Agriculture. It controls and plans the work pertaining to Heavy Industry, under the People's Commissariat of Heavy Industry. It is also in touch with various conferences and reports on large enterprises in big Centres and Scientific propaganda.

The network of scientific research as carried out in (*a*) Head Institutes, (*b*) Branch Institutes, and (*c*) Subsidiary Points, Factory Laboratories, etc., brings the Academy of Sciences in close touch with the needs of industry, creating as it were a continuous flow from the most abstract theoretical considerations to the minutest details of practical work. It is difficult to demarcate between Pure and Applied Sciences so happily interwoven together in the U.S.S.R.