

STUDIES OF SCIENCE IN THE GERMAN DEMOCRATIC REPUBLIC*

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Permit me first to thank very cordially the organizers of this symposium--the Society for Social Studies of Science and the Research Committee for Sociology of Science of the International Sociological Association (ISA)--for your invitation to this conference. This gives me the welcome opportunity to meet personally a number of colleagues whose names have so far only been known to me by the literature and thus to supplement the picture I have of them. I am pleased to have the opportunity to get a much broader and more detailed impression of the theoretical and methodological intentions of the Society for Social Studies of Science than was hitherto possible through a study of the Society's written programme. And, finally, I regard it as a welcome task to inform this symposium about some trends of development in science research in my country--the German Democratic Republic. I am especially interested in giving you some idea of the theoretical and methodological considerations which guide us in our work at the Institute for the Theory, History and Organization of Science at the Academy of Sciences of the GDR.

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In the 1960's studies of science in the GDR were still centered around the traditional scientific disciplines. Philosophers, economists, sociologists, psychologists,

historians and the like had devoted themselves to research into the various different aspects of the phenomenon science as a whole, from the point of view of the increased weight of science in Society. The content of the trends in research involved was therefore primarily determined by the relevant basic disciplines, so that for this period it seems justified to speak of a philosophy of science, economics of science, sociology of science, psychology of science and so on. It is clear that these investigations were marked by a plurality of basic concepts and of the methods, and there was no integrated understanding of science on which to build.

The first task we set ourselves in 1970, when the Institute for the Theory and Organization of Science was founded at the Academy of Sciences, was therefore to provide such an integrated concept as the basis for the Institute's work. What was required here was to provide a theoretical synthesis of the results so far achieved in science studies from the point of view of the separate disciplines and of the experience gained in the organization, management and planning of science which can serve as a theoretical basis for further research.

Various considerations associated with Marx's view of scientific activity as general work,¹ which I refrain from discussing in detail here, induced us to regard science as a socio-economically determined system of social activities or processes of work whose specific nature lies in the gaining,

reproduction, dissemination and application of systematic and methodical knowledge.²

Such an integrated concept of science could be achieved only through a collaboration between scientists in the relevant disciplines. This interdisciplinary approach was to enable us to investigate the various aspects of the development of science, of scientific activity and scientific knowledge not from the prevailing point of view of a separate discipline, or in isolation from each other, but in their complex interrelationship. This theoretical aim corresponded with the practical interests of socialist society based on the principle of planning in managing and planning science as an important integral part of the process of social reproduction not only in some of its aspects but as an entity.

Thus three significant basic principles emerged that have guided us and will continue to guide us in the coming years:

1. Observance of the social nature of science and of the fact that it is determined by socio-economic conditions;
2. an interdisciplinary and complex approach in investigating science;
3. unity of theory and practice.

The first principle means that for us science is not an autonomous system following its own laws in its movement and development but that the development of science must be

seen in close connection with the development of society, of its material productive forces and social conditions, furthermore, that science is indeed determined by these in its structure and dynamics--conveyed through a variety of relationships.

The second principle means--for the structure of the Institute--that we invited representatives of a great variety of natural and social sciences to cooperate with us insofar as they were willing to devote themselves to science research and to make use of the methodical tools of their own discipline for this purpose. Today we have working at the Institute philosophers and economists, sociologists and psychologists, mathematicians and physicists, chemists and biologists and representatives of other disciplines.

This kind of interdisciplinary work of course entailed many problems and difficulties. Our primary aim was not to engage in the philosophy, economics or sociology of science in the traditional sense; what we intended to do was to tackle complex problems of the theory of science on the basis of a system of uniform and independent terms pertaining to the theory of science. But it turned out that the representatives of various disciplines sometimes had quite a different understanding of one and the same phenomenon, for example, the philosopher had quite a different understanding of scientific creativity from that of the psychologist, the economist a different understanding from that of the socio-

logist, and so on. Claims to priority also emerged sometimes in the investigation of certain phenomena of the development of science or of scientific activity, for example, that the investigation of scientific creativity could only be done successfully by psychologists. Difficulties of this kind by working out a theory of science consistent in itself, and based on an independent and integrated system of basic terms have today been largely overcome, although we are still far from a general theory of science.

The third principle means that our theoretical work is closely connected with the practical needs of managing, planning and organizing scientific activities at the Academy of Sciences. Our empirical studies are therefore mainly concerned with basic research at the Academy and the practical output of our theoretical work is intended mainly to benefit the needs of the Academy, its institutes and the heads and staff of research teams of the Academy in managing, planning and organizing their research work.

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Let me give you an example of how these three methodological principles have been applied in investigating a specific problem of the theory of science--that of scientific creativity.

In the past, investigation of the creative work of scientists was mainly regarded as a domain of psychology, of

social psychology or, at best, of the history of science. Here interest in the stage of intellectual inspiration, mental processes taking place in the subconscious and leading to "inspired ideas" predominated. In accordance with this, psychological investigations were of course conducted with the help of the methodical tools of psychology, and of these only. From this point of view the social context in which the individual process of scientific creativity takes place was only the outward--limiting or stimulating--framework. In our opinion, however, an integrated theory of scientific creativity must be built up in interdisciplinary work by psychologists, philosophers, sociologists and others in the same way as the theory of science as a whole. In line with the second methodological principle of the construction of a general theory of science we included into this research sociologists and philosophers along with psychologists and social psychologists. We were not disappointed in our expectation that in this way, the first methodological principle would receive the attention due to it, that is that science would not be regarded as a self-sufficient system and the driving forces of scientific productivity would not be sought and found only in the region of the cognitive. Science is considered in our studies as the entirety of scientific activities which are embedded in the social activity of society as a whole and are part of this whole. Our studies of scientific creativity therefore

started out from the supposition that creative activity in science is social activity whose special characteristic is that it formulate and solves scientific or research problems. From this point of view, creative scientific activity is subject to a many-layered determination. Its progress and success depend by no means solely on conditions and factors inherent in science. Personal and methodological factors, working conditions in the institution concerned or the climate in a particular research team, also play a role. Ten years ago in the USA, D. C. Pelz and F. M. Andrews presented the results of several years of studies³ on the last two groups of conditions; we noted this with great interest. While appreciating their methods and their results, we regret to see that there is no emphasis on social conditions of scientific activity. The authors restrict themselves to analyzing only such relations as develop within a scientific team, and, in our view, fail to notice that the relations within any team are determined by more general social relationships in society. Freedom of scientific creativity, freedom to choose certain directions of research, is also, we feel, not just an organizational problem whose solution is dependent on the conditions prevailing in the organization concerned. In our opinion, choice of the main directions of research, for instance, is made on the basis both of fundamental economic, political, cultural and other requirements of the society concerned and of the level and requirements

of development in the relevant scientific discipline.⁴

Boris Hessen is known to have provided an example--unique in his time--of such a view of scientific activity in his lecture on the social and economic roots of Newton's "Principia" at the 2nd congress on the history of science in London in 1931.⁵ We consider it to be imperative for our approach to the investigation of the development of science and the structure and dynamics of scientific activity in general to take into account both the objective laws of social development and those of the development of science, furthermore, that the development of science is an integral part of the development of the given society. Such a concept is open to the reproach neither of externalism nor of internalism.

We have presented this concept as applied to the problems of scientific creativity, and the initial results of investigations, in the book "Socialism and Scientific Creativity,"⁶ and in a more general form in "Science: Status, function and organization in the advanced socialist society."⁷

As far as the third methodological principle--unity of theory and practice--is concerned, we are trying to plan investigations into the creative productivity of scientists in such a way that rules governing the social behavior of the members of research teams can be derived from them. The underlying idea is that the above-mentioned determinants of scientific and creative productivity should become directly effective in the work of research teams. From the point of

view of practical use, the investigations aim at fuller exploitation of the opportunities offered by joint work in the field of research, and thus at making a contribution towards intensifying the processes of research at the Academy.

We investigated, for instance, socio-psychological factors of joint research work, using a sample of research teams from the spheres of basic and applied research.⁸

The objectives of the investigation were the following:

1. To establish theoretically what features of socio-psychological significance characterize and influence research teams;
2. To explore empirically the type and intensity of the relationship between results of research and certain socio-psychological group characteristics.

The main method of collecting data consisted in a written interview supplemented by tables of estimates. For reasons of comparison essential documents (including research plans and expertises on research results) were evaluated.

The results show that research teams are characterized by constituting and cooperative features. The constituting features, that is, the suppositions of cooperation, include the research subject, material and technical facilities, and the personality traits of the various team members.

Research work gives rise to various relationships between scientists and towards the subject and the means of

research on the basis of the constituting features. These relations become general characteristics of a group. The emergence of cooperative group features is closely associated with coordination of work; a high group performance can be achieved only through the deliberate summation, balancing and arrangement of research efforts.

1. A statistically significant influence on the performance of research teams was established in respect of such group features which as a whole, because of their multi-dimensional nature, are suited to reflect influences on group life (e.g. satisfaction with one's work).
2. As regards the extent to which some group features evolve, research teams from the field of applied research differ from those working in basic research. This applies, amongst other things, to the attitude towards team work and to the group climate.
3. Special aspects of the objective of work or the intended result make specific demands on the attitudes and behavior of members of a team.

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Our investigations into scientific work processes in their complexity also deal with the relations between agnostic and social aspects. These studies are designed to help

discover what variables influence the efficiency of work in research teams. The main emphasis is on social aspects of research work, but with a view to exploring the interplay of gnostic and social aspects. Gnostic relationships are held to be processes determined by the connection between the cognizing subject and the object, whereas social relationships are tied to the social relations into which people are bound to enter when carrying out research work. The results of these studies have so far appeared mainly in the book "Socialism and Scientific Creativity" and in a preprint issued by the Institute on "Division of labour, cooperation and communication in socialist research teams."⁹

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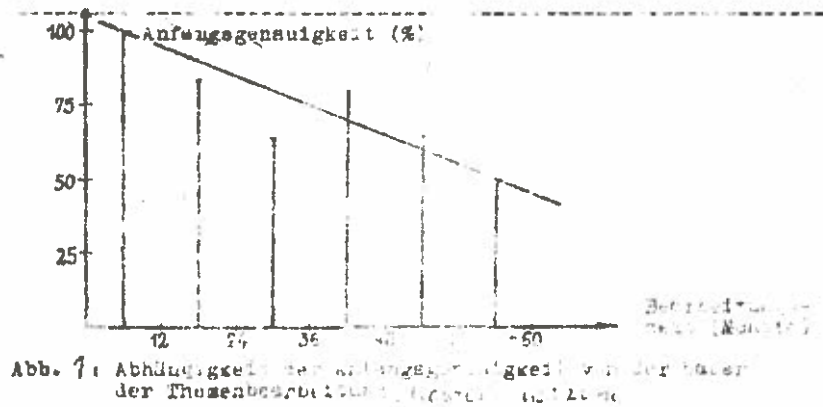
Scientific work processes conducted under the conditions of highly socialized scientific activity require social management and planning.¹⁰ We therefore devote part of our work to the investigation of theoretical and practical problems of research forecasting and planning.¹¹ One of the problems facing us here is connected with the uncertainties in the research process, for example, with regard to the aims, the methods to be applied, the manpower to be employed, and the use to be made of the results, etc. A well-founded management and planning of research as a realm of human activity situated on the boundary between the known and the unknown, between knowledge and ignorance, between mastery and

non-mastery of the laws of nature and society, calls for an increasingly systematic investigation of the problem of uncertainties in research, since it gives rise to specific requirements in forecasting and planning in this sphere of activity.

Initial studies have shown that there are various possible and meaningful points of departure for characterizing uncertainties of research and taking them into account in planning. One possibility for the field of applied research and development is the quantitative measurement of the dependence of the preciseness of certain plan data (as an expression of uncertainty) on the time a subject is worked upon (see graphs 1 and 2). This quantitative determination can serve as an important point of departure for precision in planning future research topics; corrections and tolerances can also be derived from it.¹²

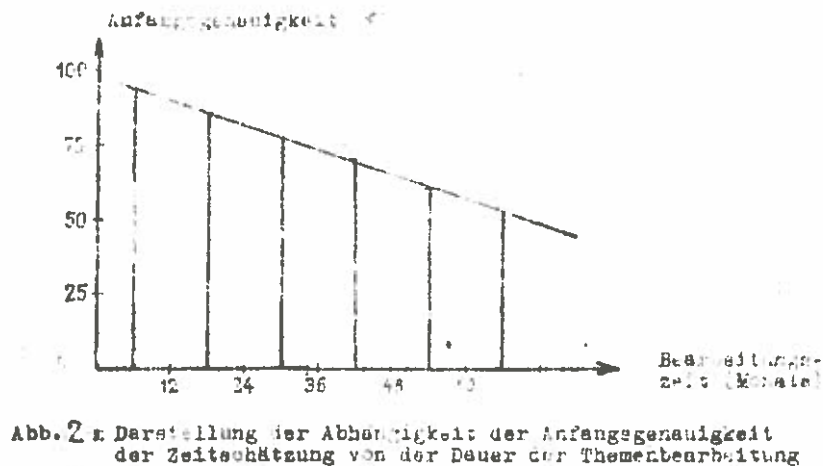
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The success of creative scientific activity is highly dependent on the methodical approach in research or: method led procedure. In this context we are interested in methodological and logical problems occurring in scientific cognition and rational action in the field of research. Proceeding from the view that science is a specific kind of social activity, we believe we have developed our own basic concepts for investigating such methodological problems of



Graph 1: Dependence of initial precision on the duration of work on a theme (cost estimate)

1. Initial precision (%)
2. Duration of work (months)



Graph 2: Dependence of the initial precision of the estimated duration on the actual duration of work on a theme

1. Initial precision (%)
2. Duration of work (months)

research. These include the interpretation of the term "problem" as an expression of a specific aim-condition-relationship, and the concept of the method led procedure in research as an interaction of various types of mental elements (rules, problems and principles) within an aim-condition-relationship.

In this connection an original method devised at the Institute should be mentioned. According to this method the development of scientific disciplines is not only characterized by such external features as the number of publications, size of manpower or volume of the financial means invested, but rather through parameters connected with elements of scientific cognition itself.¹³ Such elements of scientific cognition are, for example: the cognitive problem, the method of cognition, the result of cognition (fact, hypothesis, theory, etc.) and the cognitive function (description, explanation, theorization, etc.).

In scientific research cognitive problems are raised, worked upon and solved. In an area of scientific work (e.g. a branch of science, a scientific discipline, or part of a scientific discipline) a given totality of problems is dealt with in a given period of time. A totality of problems being worked upon is called a "problem area." Problem areas are determined or limited by their relationship to a certain field of scientific work, to a given period of time and to a certain system of scientific institutions. The totality of

problems forming a problem area can be structurally described under different aspects. Our approach was based on the question as to what the quantitative relationship is between the problems occurring in the period under review with regard to their classification into certain types. (Which types of problems are dominant, which are less frequent, etc.?) We have oriented our investigations of the structure of problem areas in the empirical sciences on a classification of research problems according to their cognitive function. On the basis of methodological analyses it has been established that the following basic types of problems occur in the empirical sciences if these are viewed from the angle of classification of problems according to their cognitive function: problems of single description, problems of generalizing description, problems of explanation, and problems of theorization. It may be assumed that these types of problems are focal points in a general model of the method led procedure in the empirical sciences.

The structure of a problem area in a sphere of scientific work, related to a given period of time and to given scientific institutions, can then be described by a multilinear proportion between the problems of single description, generalizing description, explanation and theorization which occur. This brings up the following methodological difficulties:

1. As a rule it appears to be impossible to obtain a

description of the structure of the problem area of a sphere of scientific work by analyzing all problems worked upon in the period under review and identifying them according to the given criteria of classification. It is necessary to rely, when analyzing the structure of the problem areas of entire scientific disciplines or lines of scientific work, on representative publications, periodicals, institutions, etc. Empirical surveys can be made at scientific institutions or by analyzing original publications.

2. A second difficulty is to select the problems from original publications and to identify the relevant types of problems. On the basis of the theory of text analysis, methodical principles have been worked out for the analysis of research reports for the purpose of identifying types of problems. The problem area of biophysics has been chosen as a subject of investigation so as to illustrate our tentative analysis of problem areas. Two volumes of the periodical "Studia biophysica" (1966, 1972), provided a representative section of the problem area of biophysics. This example picked out for investigation showed that there was no significant difference between the structure of the problem area in 1972 and in 1966, i.e., the problem area was the same.

The analysis of problem areas can, in our view, make an essential contribution towards investigating the development of science: comparative studies of the structure of the problem area of a scientific discipline at different periods

of its development and comparison of different scientific disciplines with regard to historical change in the structure of their problem areas can help discover general traits and laws of development of science. The level of development of scientific disciplines can thus be evaluated on the basis of criteria connected with the structure of problem areas. Findings on alterations in the structure of problem areas are also of prognostic importance for science.

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Finally, a last remark on the way in which we are carrying out our studies of science. The methodological principles of our work also include unity between the logical and the historical, between the theory and history of science. We consider studies in the field of the history of science to be an important element in various respects, a constituent element of the theory of science. We have therefore started this year upon relevant research into the history of science at the institute.

I know that what I have said can have given you neither a complete picture of the work done by our institute nor a detailed description of individual investigations and their results. As I pointed out to start with, it was my intention to indicate some theoretical and methodological considerations guiding us in our studies of science.

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