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SCIENTIFIC TEAMS AND THE DEVELOPMENT OF CREATIVE POWERS

I

A group of scholars invited by the Polish Academy of Science and the Ministry of Advanced Education met at Jabłonna on May 21 and 22 1965. The topic of the conference concerned organization and leadership of scientific teams from the point of view of achieving maximum efficiency in dealing with scientific problems, while optimum conditions of developing creative powers of team members are assured. The discussion was based on a paper given by professor Aleksander Matejko. He presented the results of research on scientific teams sponsored by the Interuniversity Institute for Research on Advanced Education; other papers were presented by Professors: Celina Bobińska, Władysław Findeisen, Konstanty Grzybowski, Leopold Infeld, Tadeusz Kotarbiński, Ignacy Malecki, Edward Marczewski and Aleksy Wakar. The present author opened the Symposium, in absence of Professor Ignacy Malecki. The floor was held by 21 speakers, and the discussion often changed into heated informal conversations and disputes. The proceedings of the Symposium will be published separately; the present report is only meant to present its basic ideas, the ways of approaching separate problems, as well as a summary of conclusions and new questions raised during its sessions.

II

The interest in team work on scientific problems and in all that follows it results from changes occurring in the methods of scientific research, as well as, from developing tendencies of scientific organization. Modern science is also going through an „organizational revolution", which modifies the scientific workshop and changes the social role of the scholar leading to the necessity of altering the methods

of education of young scientists. It could be said, in short, that this revolution promotes the transition of science from the „academic" to the "industrialized" stage, if such a definition may be meaningfully applied.

The scope and the quality of changes under way are best illustrated by the following facts: the ammount of institutions engaged in research grows rapidly, and this is connected with rapid differentiation of those institutions from the points of view of their tasks, organization of labour, principles of research, aims and status of their staff. In this country university chairs, institutes of the Polish Academy of Sciences, central institutes, institutes of the separate ministries, industrial laboratories as well as other institutions also engaged in research work can be taken as examples of such differentiation. Their aims and their labour organization diverge, and last not least they have different "general attitudes" concerning science, what will be subject to ample discussion.

On the other hand, a rapid growth of the number of scholars is under way. During the academic year 1938/39 there were some 3000 professionally employed scientists in Poland, while the same figure for 1964-65 amounted to some 55000. This is due to the expansion and differentiation of the types of research institutions. But there is also another phenomenon, observed all over the world, namely, that the functioning of modern society requires an increasing amount of scholars. It is obvious, that this leads to a differentiation of their status within the institutes, and a diversity of careers and types of personality. The pattern of a scholar, as the ideal type to be achieved, is also subject to change. The role of the organizers gains importance, since altering targets of research work require increased cooperation between large groups, and even for the solution of partial problems whole teams, and not individuals, as before, must join their forces.

Thus the development tendency is very clearly featured by team research, far reaching division of labour, resulting in disintegration of tasks performed by separate research workers, and also by teams, composed of different specialists, working on the solution of one problem. This leads to the importance of organizational problems and methods of organizing cooperation within teams: one should consider, how to make the most individual qualities of the research workers, without waisting their talents. Thus the tasks of the leader of a team become different than the ones of the head of a scientific school or the head of a traditional chair, educating future scientists.

The chairs at academic schools also change their character, especially in technical education, where "auxiliary enterprises" are connected with separate chairs. Such enterprises are engaged in research on commission, and this gives them some features of business. Thus the

methods of educating young scholars are also changing at the advanced schools, since their basic attitudes are shaped in the first instance by those "auxiliary enterprises". On the other hand, the traditional, academic style of research work still exists, at the departments of humanities, and also at such other departments, which are not related to practical economic requirements. The same style also persists, to a certain degree, at many institutes of the Polish Academy of Sciences, as well as at those centers in which the men in charge are inclined towards the solution of basic problems, since having worked out their own sets of hypotheses and theories they tend towards organizing schools of scientific thought.

Broadly speaking, diverging tendencies may be observed in scientific activity. On one hand, we are confronted with "academic" science, pursued at universities and at those institutes which are concerned with basic problems. The leaders of such centers tend to develop the creative powers of their pupils. Their basic aim is to organize a school, considered as a team of creative individuals working on the solution of a more or less joint set of problems, within the assumption of one theory, or one set of hypotheses. On the other hand, we are confronted with institutes, subject to separate ministries, which are engaged in applied research, being actually service activity for solving definite, detailed problems. In dealing with such questions, *ad hoc* teams are put together, the only aim of which is quick and expedient solution of a given technical problem — while the question of creating a school or developing creative individualities is never raised. That is why, within the institutes subject to separate ministries or in other centers confronted with such problems, there is growing interest in research methods useful to this kind of teams and in scientific methods of organizing research activities. There are no educational traditions, no traditions of academic work, and the word "scientific" means only "technically correct, reliable, expedient". A specific "philosophy of applied science" is originating, different from the one which developed at the end of the 19th century and which still is accepted nowadays at the universities. The latter was explicitly discussed in the Symposium papers, where science was presented as a vocation, a service to truth, a pure confrontation of the mind with cognitive problems.

III

The problems raised at the Symposium followed from those facts, or rather from the anxiety, which they provoke. Recognizing that team work will gain importance in the course of development of science, the organizers wished to have a closer look at the questions raised by those developments. The first one concerns differences between vari-

ous kinds of teams, depending on their special field of investigation, the institution with which they are connected, the personality of the man in charge, and the kind of tasks, with which they are confronted. The Symposium confirmed, that representatives of academic science attach a completely different meaning to the word "team", than those representing technical sciences, and especially technological institutes. The former chiefly visualize a "scientific school", working under the leadership of its master within a theoretical framework which he created, while the latter mainly have in mind a team called *ad hoc* to solve definite questions. The former are interested in developing the personality of their pupils, the latter — in solving a given problem. The former understand their leadership of the team as a long process of education and coordination of individual endeavours, the latter as division of labour and coordination of the results of work divided between several specialists. For the former methods of labour organization are mainly theoretical and methodological problems, while for the latter, they consist in techniques of achieving expediency. The Symposium proved, that it is extremely difficult to find a common language for those two schools of thought.

The next task confronting the Symposium was the discussion on organisational patterns, assuring simultaneously the greatest possible scientific expediency, and best conditions of development of creative powers. Immediately the problem of selection of the members of the team, of their rotation and of its durability *etc.*, arose. Further, there is the question of the role played by the leader of the team, of his participation in the results achieved and in the development of creative powers. It is evident, that the leader has a decisive share in the choice of numbers of the team, in organizing cooperation and in shaping relations within his staff. The importance and the role of individual features of the members of the team in achieving scientific results was also discussed.

The set of problems was vast and complex. The papers and especially the one by professor Matejko, presented preliminary results of research on a number of scientific institutions. Other papers contained personal experience in managing scientific teams. Thus, the first results of research and personal experience had to be put together, in order to obtain a basis for preliminary systematization of knowledge and for elaborating a set of concepts, which could organize the experience gained by practical participation in, and leadership of scientific teams. It is obvious, that nobody expected complete results. The organizers hoped, however, that the exchange of thoughts will determine basic ideas, which in turn will help in research and in organization of personal experience, leading to problems much more specific than the ones initially defined.

IV

The paper by professor Matejko, as well as the results of the discussion concerning organization of scientific teams showed how difficult it is to pass from facts known from every day experience and intuition, to generalizations and rational patterns of thought. Other factors determine the efficiency of a team of a type of a scientific school in the traditional meaning of the word, than the ones, determining the efficiency of a technical team, in which a group of specialists solves definite and detailed problems. In this last case, specialization of the team requires from its members a number of skills, which other members do not need to master; their skills and knowledge are thus complementary, and the task of the leadership consists in applying them efficiently. On the other hand, a scientific school consists of a group of people fully developed and independent in their creative powers. The principles of their choice are also different. In such centers where quick and efficient solution of given problems is most important, other features are taken as criterion of choice, namely: the range of specialization, experience in cooperation within "disintegrated" work, discipline and subordination to the leader. In the case of scientific school, the choice is mainly based on creative powers, character, love of knowledge and personal passion in dealing with problems. Much was said on all this during the discussion. It was pointed out, that for the choice of future scholars, that is to say, those who after graduation enter the famous "university channel", in order to emerge from it after many years as professors, such features of character as honesty and intellectual thoroughness are more important than brightness and broad interests. This "channel", however, of which Professor Celina Bobińska spoke so much, has this peculiarity, that a candidate, who has once entered it, can not be removed, and since it is easy to make a bad choice, the "channel" is often left by professors, who are far from the ideal picture.

Thus it was agreed upon, that distinction should be made between the education of scientists and the education of "workers" of science, who all their life work in technical teams, performing partial, casual tasks, some time even of great practical importance, but who never will educate others or form scientific schools of their own.

Much attention was also paid to the problems of stabilization and rotation within scientific teams. The differences of opinion concerning the style of work of university chairs and technical institutes were also marked in this respect. The system of rotation, resulting from educational necessities makes it impossible to transform chairs into highly specialized research institutions, since their staff is constantly absorbed with individual research work, according to the requirements

of law concerning academic degrees. Rotation is impossible in a technological institute, where partial specialization as well as experience gained in "dispersed" work are often a condition of success in solving given problems.

Systematically assembled and elaborated material in this field is not available, and that is why the separate opinions often contradictory were based on various arguments, which could not be verified or solved. It was also impossible to determine respective interrelations. First of all, various kinds of teams of intermediate character between the two opposed "poles" of a scientific school and of a team *ad hoc* must be classified. It is only then, that the tedious work of systematizing knowledge gained from every day experience, based on the functionning of scientific teams can be started. And it is also then, that one can begin organized studies on the influence of different organization patterns, on the effectivenness of scientific work done by the members of the team.

V

Much attention was also drawn to the role of the leader of the team. In a scientific school, the personality of the leader, his creative powers, his knowledge of raising interest and enthusiasm for work, are decisive. If the leader has no ideas of his own, and if he can not convince his pupils about them, in other words, paraphrasing a known saying of professor Hirszfeld — if he is not burning himself — then he will not light up enthusiasm in anybody. This is, however, a marginal case. Between a scientific school and a team *ad hoc,* there exists a great number of aspects of team work, in which the leader plays a decisive part. In an academic team, the interest of the leader is focussed on the personality of its members. During discussion many professors (Ingarden, Minc, Vetulani, Gwiazdomorski, Aleksandrowicz, Jakubowski and others), spoke in a beautiful and convincing way of the educative tasks of the professor supervising work of young scholars. Various types of leaders were also discussed; they could be classifield as follows: the leader of a scientific school, the leader and organizer, the leader as a paymaster. The last one has the skill of raising money for research, and this concentrates around him a great number of collaborators. Those types of leaders establish various types of institutions, exert pressure on the economy, on science *etc.*

In various types of teams, the leader is interested in different problems. Professors are always convinced, that in the first place their assistants are future scholars and academic teachers, and thus

the relation master — pupil lies at the base of their leadership. Nevertheless, even at the universities, the position of the leader is shifting more and more towards one of an organizer, from that of a scholar in the traditional sense. On the other "pole", the leader of technical teams *ad hoc* is in the first instance an organizer of the activities of their members. He is not interested in their ways of thinking and their personalities. As a matter of fact, he could even ignore their names, if he had them numbered. He is only interested in their capacities of solving "disintegrated" problems, their knowledge of co-operation, of keeping the timetable of work *etc.*, since his only concern lies in the solution of the problem. This extreme type of leader, who is only an organizer, becomes more and more frequent in research centers, which are far from academic patterns of scientific work. It should be emphasized that this tendency is increasing at advanced schools, especially at technical ones, and at the institutes of the Polish Academy of Sciences. It becomes more and more frequent, that the scientific leader stands at the head of teams composed of several decades of people, whose work can be no more supervised according to the traditional "master — pupil" pattern. In such cases his tasks become predominantly organizational ones. One should distinguish various meanings of the term: "organizational and managerial work". The management of a big institute or of a whole field of knowledge in many scientific institutions is a completely different problem than supervision over scientific work in the strict sense of the word, that is to say patronage over the young scholar, help in setting up the problem, collecting material, its analysis and elaboration must be clearly distinguished from leading the team and organizing its activities that is to say, from determining partial tasks, coordinating separate achievements, *etc.*, while the management of a big institute or a whole field of knowledge in many scientific institutions is again a completely different problem.

The range of decisions and their subject is different at all those levels; other features of personality and a different attitude towards his collaborators are required from the leader. In any case, the relation: "master — pupil" tends to lose its importance as the basic principle organizing mutual influence between the leader and his team. We are frequently confronted with teams, in which the leader has no teaching activities; he only allocates tasks and coordinates work, controlling the advancement of specialized research in which he is no better specialist than his subordinates.

This important factor must also be taken into account, when education of young scholars and leaders of scientific activities at various levels is considered.

VI

The importance of the internal tie within the team, of mutual relations between its members and of the influence of those relations on the expediency in solving problems, and on the individual development of qualifications of its members, were discussed next at the symposium. Professor Matejko presented the results of his research in this field, while personal observations and experiences were added during the discussion. The importance of those relations for shaping the internal ties within the team was stressed, the selective influence of attractive problems was shown. Such problems open broad prospects for theory and research, they attract enthusiastic scholars striving towards discovery. Much was said about the "atmosphere" of the team, developed by its leader and his cooperators fascinated by the prospect of discovering an unknown world. Some teams on the other hand, originate from the attractiveness of a leader-paymaster, who has the ability of raising money for research and assuring good earnings to his team.

It is obvious, that the problem is different in teams working within the chairs of academic school, (depending on their special field of study), and those of the technical institutes. The necessity of achieving scientific degrees on the basis of individual research does not permit to organize teams working on one problem, or at least it leads to serious difficulties in setting them up. That is why the ties between assistants of a chair are the same as those between members of a team solving one problem in common.

Professors Zieleniewski, Wakar and others presented an attempt at systematizing experience on the basis of rational categories, taken from a general theory of organization and leadership. This however indicated, that the way towards a theory from which one could draw instructions for practical action is still very long, although such attempts are themselves very useful and necessary. Preliminary research and every day experience show, that great forces shaping motivations, ambitions and creative endeavours of the members of the team are latent within the field of their mutual interactions, the game of their attitudes, their emotional reactions, their mutual help and rivalry. In a research team, as in every elementary group, the influence of the group itself is predominant for the development of tendencies and the intensity of aspirations of its members. Thus it is essential to give the leaders of such groups some suggestions how to make the best use of the creative powers of their teams.

The role of a team is vital for every institution. Even for small teams of assistants working within a chair, the atmosphere of cooperation has an important influence on their creative achievements.

This is of much greater importance for big teams, in which personal contacts of the leader with members of his team are rare. But positive knowledge which could be used in activating such powers and which could help in practical decisions is very limited. One could apply here the achievements of sociological research on small groups or existing theories of social behaviour, but an adequate "translation" of such general theories into the language of every day practice is, as yet, not available. The Interuniversity Institute of Research on Advanced Education is going to publish a study by professor Matejko, containing reports and surveys of Anglo-Saxon literature in the field, which could be a starting point for further work.

VII

The problem of education of scholars attracted much attention during the discussion, since it is always the basic task of advanced schools. The style and methods of work at academic chairs, the prevailing philosophy of science and scientific work, the example of professors and their personal beliefs, have a crucial influence on the attitudes of future scientists and on their ideas of scientific work. The traditional pattern of an academic scholar is always the ideal type accepted consciously or subconsciously, according to which scientists are being educated. On the other hand, in an increasing number of research centers, staff members are needed, who would be able to perform "partial" tasks expediently. In a sense, one could call them "technicians" of research work. Such people do not determine independently their tasks and problems, they do not elaborate their own research methods, but they only perform partial work within the teams. The type of education which they obtained tells them, however, that this kind of work is "contrary" to the only one "worthy" of a scientist, thus leading them to frustration and discontent, which are always negative for their work and their mental attitudes.

Thus, the problem has many aspects. The first one concerns the teaching of methodology of science and the shaping of ideas on scientific activity according to models, which are incompatible with modern, "industrialized" scientific institutions, where applied research is predominant, and where a philosophy of "applied science" prevails. Thus, the teaching of such a methodology of science which primarily concerns basic research, and which shapes the ideas of young scientists on the aim of science, as work concerning general theories, leads to conflicts between their ideas on science and their definite tasks.

The second aspect concerns initiating young assistants in research work within big groups, the leader of which has little time and fiew chances of supervising directly the beginners' work. Professor Vetula-

ni claimed, that the professor should complete at least one study together with his young assistant. This, however, can not be done in big institutes, where there is one professor per many decades of assistants, or in such teams, where the leader is only an organizer, unable of saying anything about the factual work of his staff. Thus, the way of a young graduate towards professorship, so important for the development of his creative powers and for achieving practical research skills, has not been investigated theoretically, and also neglected in practice.

Various aspects of the "rotation" of scientific workers within chairs and institutes, as well as "immanent contradictions" of this process were also subject to discussion. Such questions were raised, as: involvement in individual work in order to obtain academic degrees, contradiction between such work and improving teaching skills, automatic functioning of the "academic channel", which pushes through anybody who entered it towards a professorship, irrespective of talents and skills *etc.* On the other hand, the prevailing type of work done at research institutes does not correspond to legal requirements concerning doctoral dissertations and other academic degrees.

This led to rather timid proposals of basic reforms, which should involve academic schools and research institutes of all kinds. Such reforms should tend towards a harmony between actual reality and the tacit ideals of science and of philosophy of science. But the idea of such reforms was rather tacitly latent in the air, since it was the general feeling, that our scientific institutions are in a state of permanent reform: one law chases the other and before all executive regulations are available, the next law cancels them. Scientific institutions also need some stabilizing period, and that is why basic reform was discussed reluctantly. In the present author's opinion, one basic reform every 20 years is better than small amendments every year.

VIII

What plans and blueprints of further research were discussed during the Symposium? Everybody agreed, that it is necessary to systematize practical knowledge concerning the leadership of teams and their organization, and also that systematic research should be made on how to develop scientific talents and how to organize teams, in order to shape correspondingly the attitudes and tendencies of their members, develop their talents and skills, and make them into an efficient tool of solving problems collectively. It is easy to make such claims, the discussion showed, however, a lack of standard knowledge in the field. Undoubtedly, each leader has his own "theory" and his own "method" of action. His own opinion on such theories and methods

differs however from the opinion of his subordinates. Certain experiences have also been gathered during research. Finally it was agreed upon, that further work on the problem should be done according to the three following ways:

1) Collect the opinions of the leaders of scientific teams, which describe their experiences; systhematize them and draw general conclusions.

2) Organize empirical research on scientific teams of all kinds, apply experimental methods in order to achieve verified knowledge on separate processes and interrelations.

3) Follow systematic world literture on the subject. Those three ways of further research will be followed by the Interuniversity Institute of Research on Advanced Education.

Research will have to be followed on institutions of all existing types, in order to embrace every "branch" of scientific activity. It seems, that we are witnessing not only a division of labour in scientific research, not only a specialized distribution of scientific disciplines, but also some much more far reaching partition. As yet it is impossible to determine it adequately, though it seems to raise anxiety since it is a division into "pure, academic" science and "practical, applied", or "technological" science. If we consider, that the authorities are fascinated mainly with the latter, and that development plans provide for the allocation of by far the greater part of resources aimed at sponsoring research to this second type of activity, it may easily be seen, that this could lead to a loss of balance in the development of science. On the other hand, despite those partitions, the unity of science, and especially the unity of both basic and applied research, are obvious for each scholar. Institutional divisions, forming all kinds of groups of interests and various pressure groups competing for influence and resources, do not have the least influence on the development of science as a joint set of theorems, hypotheses and theories. Thus, in the research ahead, those basic aspects of development of scientific institutions and scientific groups, should not be lost from sight.