Zvorykine, Anatoli A.

[Professor Olszewski's lecture...]

Organon 1, 231-236

1964

branches of science are undergoing a process of bifurcation, but we do observe a process of integration too, some branches of science being joined in one, as for example in the case of cybernetics.

Professor Kedrov claims besides that the contemporary science is undergoing a process of integrating, because we observe that in between two sciences as for example physics and chemistry there appears a new branch — physical chemistry. But the process of integrating is, I think, a very specific one, as no individual is able to have an outlook on the whole body of science. Such an outlook is like a platonic idea — it exists for the mankind as a whole, but an individual is today further from catching it, than ever in the history of mankind. The development of science is very, very rapid; a physicist, for example, cannot grasp the whole of physics. Professor Oppenheimer quoted as an example that he had taken part in a symposium of physics when the fundamental paper was understood only by very few participants of the meeting. An integrating outlook on the whole body of science is therefore for an individual of our time a platonic idea.

I suppose that these remarks are an example of the usefulness of collaboration between historians and philosophers of science. Prof. Kedrov's paper seems to me essentially right, but it would be necessary to clarify such concepts as simplicity, analysis and synthesis and the understanding of the logic of choosing the explanatory postulates.

E. Rosen

According to Professor Olszewski, periods in political history are sharply defined, whereas periods in the history of science and technology are not sharply defined. But in political history, some periods are not sharply defined, for instance, the fall of the Roman Empire. And in the history of observational astronomy, we know the year and the day, and very nearly the minute, when the period of telescopic observations began. The same may be said also for the beginning of the period of radio astronomy.

A. A. Zvorykine

Professor Olszewski's lecture attracts the attention of all the historians of science and technology as both from the theoretical and practical point of view every scientist — when preparing works concerning the history of science and of technology — ought to resolve in

some way or other the problem of periodization. Myself, I was already concerned with those problems and published in 1957 an article *On Some Questions of Periodization of the History of Natural Science and Technology* [1]. On receiving Professor Olszewski's lecture, I have once again read my article and have not found necessary to change anything in the principled approach to the question.

We still now happen to come across the phenomenon that many historians of science and technology regard the problems of periodization as purely practical ones, as problems to be resolved when preparing their works. As a result, they underestimate the methodological problems and by the same token — in essence — they leave open the very question of periodization.

The value of Professor Olszewski's lecture lies chiefly in his posing the problem as one of the most important theoretic problems of the history of science and technology. All Marxists agree with each other that — when periodizing the social phenomena — the study of the social and economic structures should be the starting-point. It is to be kept in mind, however, that every group of social phenomena has its own pecularities. Hence follows a general conclusion that the periodization should not be introduced into particular groups of phenomena but deduced from the peculiarities of the development of those phenomena.

It is the objective course of history that helps to define the internal periods, into which history breaks down. When confronting, for instance, the periodization having been accepted by Russian historians adhering to various methodological positions as to the history of Russia, there may be noticed some coincidences with the periodization adopted by Marxist historians. And it is no mere chance. So eminent a historian, as V. O. Kluchevsky, could not help unconsciously reflecting in his periodization those objective real periods in Russian history that are being singled out by Marxist historians consciously proceeding from the Marxist theory and analysing the actual development of the history of Russia.

In the field of the periodization of the history of natural science and technology — both from the theoretical and practical point of view — even less has been done than in the domain of general history, although this question is not new. In the capital works on the history of science and of particular branches of natural science, published in the XXth century, those questions have been resolved in some way or other, and besides from several points of view. Some historians of science establish periods in part coinciding with socioeconomic epochs, and

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[1] А. А. Зворыкин, *О некоторых вопросах периодизации истории естествознания и техники.* "Вопросы Истории Естествознания и техники" ("Problems of the History of Science and Technology", vol. 4, 1957).

within the framework of general historical periods they arrange the material according to the chronological principle or according to the most important discoveries. There are periodizations where the methods of nature's cognition are being taken as a criterion, for instance the periodizations about the degree of dissemination of inductive research methods. In our country a great work in the way of the theoretical inquiry into the problems regarding the periodization of the history of natural science is being carried on by the here present Professor Kedrov. I will not dwell on his conception, although I did so at one time — as it will be discussed here, too.

In the light of all that has been said I should like to dwell on the lecture of Professor Olszewski since he has formulated new interesting ideas about the periodization. Professor Olszewski's proposal is to assume as a basis of periodization Kuhn's conception proceeding from paradigms deduced by him. It is just the origin of the paradigm that is recommended to be assumed as the basis of the periodization of the history of science. There arises the question: how is the paradigm to be understood — as a discovery and development of the determined laws of nature or as a subjective comprehension and recognition of those laws?

It is the latter comprehension of the paradigm that follows from Professor Olszewski's lecture; it turns then out that the history of classical mechanics is not to be begun from the moment when the *Principia* of Newton appeared, that is from the year 1687, but from the moment when the proposition of that mechanics was universally recognized — or that the history of the newest stage in the development of biology is not to be taken from the moment when Darwin's work appeared, that is from the year 1859, but from the moment when Darwin's proposition was universally recognized.

The history of science, more particularly that of the early stages, shows us a wide gap between the scientific discoveries and their general acknowledgment or a broad reformation of the system of scientific thought in the light of those discoveries. That is why the historian of science who writes books, and consequently also the reader, will be put in an awkward position when performing the periodization on the basis of Professor Kuhn's paradigms. Would it not be better to keep on examining the development of the history of science within the framework of socioeconomic epochs and singling out the generality which characterizes the science of each period. Within the period, however, to single out the particular branches of science as they are forming and developing, and to take the scientific discoveries made by particular scientists as initial turning-points of the history of science.

When taking the really proceeding phenomena (and not the judgements about them) as the starting-point of the periodization, we negate

of course a simple solution of the periodization problem for the history of natural science as a whole, for the history of technology as a whole, for the history of particular branches of science and technology, for the history of particular constructions and processes, for the history of particular problems. Whenever the history of one or another phenomenon is to be divided into periods one should seek for the answer to the periodization problems in the peculiarities of those phenomena, by following — as it seems to us — the aforesaid general considerations.

I should like to dwell at greater length on the periodization of the general history of technology since I am both theoretically and practically concerned first of all with these problems. What is to be assumed as a basis of the periodization? Of course, the qualitative transitions in the development of instruments and means of labour since it is they that, in our opinion, determine the contents of technology. And if so, the scheme of the development of instruments and machines, presented by Marx in his *Poverty of Philosophy* may be assumed as the basis of such a periodization. Here is the scheme in question: "Simple instruments; accumulation of simple instruments; complex instruments; putting the complex instrument in motion by means of one motive power — by means of man's hands; putting those instruments in motion by means of natural power; machine; system of machines having one engine; system of machines having an automatically working engine" [2]. It is here that comes to light, as it were, the internal logic of technological development and the internal logic of the development of technology. Technology however develops not only by proceeding from the internal logic, but also by proceeding from the social laws. In consequence, two coincident principles of periodization are to be accepted for the general history of technology: according to the internal logic of the development of technology as such, and according to the socio-economic periods which concide historically and logically.

The basis of such a periodization has been given in my aforesaid work and an attempt at a practical application of this periodization has been made in our collective work on the history of technology [3]. The periodization in question amounts to the following:

1) Origin and spreading of simple instruments of labour in the conditions of the primitive communal mode of production.

2) Development and spreading of complex instruments of labour in the conditions of the slave-owning mode of production.

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[2] K. Marx, *Poverty of Philosophy.*

[3] А. А. Зворыкин, Н. И. Осьмова, В. И. Чернышев, С. В. Шухардин, *История техники.* Москва 1962 (A. A. Zvorykine, N. I. Osmova, V. I. Tchernyshev, S. V. Schoukhardine, *History of Technology*).

3) Spreading of complex instruments of labour, set in motion by man, in the conditions of the feudal mode of production.

4) Formation of prerequisites for the creation of machine technology in the conditions of manufactory period.

5) Spreading of steam driven machines in the period of capitalist victory and consolidation in advanced countries.

6) Development of the machine system on the basis of electro-transmission in the period of monopolistic capitalism.

7) Transition to the automatic system of machines in the period following the Great October Socialist Revolution.

In a collective work, one is obliged to give in to the opinion of one's colleagues, but I should denominate the last period the same way as I had argued at one time: "Preparation and realization of the transition to the automatic system of machines in the conditions of the general crisis of capitalism and of the building of socialism".

As everybody knows, the concrete historical materials, both in the domain of natural science, and in that of technology, are — practically — not easy to be kept within any logical period since there always are some nuances, now and then very substantial, connected with the peculiarities of the development of science and technology in time and space, nevertheless — while constantly realizing a certain conditionality of the established periods and above all the distribution of the material throughout those periods — we should not grieve about that, inasmuch as the periodization is subject to a certain logical scheme purified from a number of concrete historical deviations.

Professor Olszewski says that the lack of synchronism in the development of technology in particular countries prevents from holding to the general periodization of the history of technology. I am not inclined to agree with that. There is a striking example: the industrial revolution in the XVIIIth and XIXth centuries. That revolution — for various countries — did not coincide in time, and a general exposition of the joint history of technology in that period would seem to be impossible. But when we examine the industrial revolution of different countries, we see that the internal stages and the logic of technological development are remarkably coincident. Everywhere that industrial revolution begins with the creation of new machines in the textile industry, whereupon the problems of new energetics (emergence of steam engines) come to the fore, then the production of machines by means of machines, the revolution in metallurgy, mining and chemistry, and the final stage: machine re-equipment of the transport and appearance of new means of communication. The same can be — more or less approximately — observed within the development of technology in other periods.

I should like to dwell on another important problem raised in Professor Olszewski's lecture: on his stating that the development of

technology precedes the changes in economic and social relations. The problem of the interrelation between technology and the socioeconomic moments is not so simple as it may appear at first sight. It would seem that in the light of the law of correspondence between the relations of production and the character of productive forces, a new technology should at first arise within the old society, and then be followed by a reconstruction of the economic basis and of the corresponding superstructures. In reality — as Marx pointed out when analysing the transition from feudalism to capitalism — that process is far more complex. At the first stage of their development, the productive forces come in conflict with the old relations of production, leaning not upon the new, but upon the old technological basis, and securing in this connection a formal subordination of labour to capital. Capitalism exists under those conditions as a structure within feudalism. The formal subordination of labour to the arising forces of capitalism leads — in its internal movement — to the creation of a new technological basis being a real condition for the consolidation and development of the capitalist mode of production.

There comes — as Marx says — the economic revolution which on the one hand brings about real conditions for the domination of capital over labour, and on the other, generates conditions for the origin of a new, socialist mode of production which is able to remove the contradictory form of the development of capitalist structure. The transition from capitalism to socialism takes place, too, in a situation when within the capitalist society there does not exist a material-technological basis peculiar to socialism, let alone to communism.

Well-known is V. I. Lenin's statement against the Mensheviks alleging that Russia has not attained the level of development of productive forces that makes socialism possible. Deriding such a comprehension of the transition from capitalism to socialism, V. I. Lenin pointed out that the solution of the said problem necessarily required a consideration of the concrete conditions of the country; by advancing the plan for the electrification, for the industrialization of the country, for the collectivization of the agriculture, as well as the program of a cultural revolution, V. I. Lenin determined the ways of creating the material-technical basis, adequate to socialism.

R. Taton

Je pense que le problème de la périodisation des sciences, tout comme celui de leur classification, se présente sous deux aspects essentiels, l'un philosophique et méthodologique, l'autre pratique. Ce dernier aspect