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S. V. Schoukhardine

ON PERIODIZATION OF HISTORY OF TECHNOLOGY

In order to approach scientifically the comprehension of the development of science and technology as well as to draw proper conclusions, it is necessary to establish a scientifically-grounded periodization. Professor Olszewski is perfectly right when saying that the qualitative changes in the development of science and technology should serve as a starting point for establishing the periodization.

Professor Olszewski undertakes in his lecture the task of working out the principles of periodization for the history of particular sciences and particular domains of technology as well as for works concerned with the universal history of science and the universal history of technology. We should like, first of all, to emphasize that a universal periodization for all kinds of historico-technical and historico-scientific investigations is not possible. Although the departure positions of the periodization may be common, none the less the approach to the solution of problems regarding the concrete investigations ought to be different.

We are not able to concur with the lecturer's affirmation that both in the history of particular sciences and in the history of particular domains of technology the processes are going on analogically although — as Professor Olszewski remarks it — there exists a difference "as regards the material elements".

It is to be said that — when determining the main periods in the development of particular sciences — decisive should be, as it seems to us, the great discovery which represented a qualitative difference with regard to the level of science in the previous period. Thus, for instance, the discovery by D. I. Mendeleev of the periodical law of elements underlies a new period in the development of chemical science (let us say to the point: not only of chemical science). He discovered the objective law of nature. And it is not a question of when and who recognized that discovery, since the very fact of the law's discovery commenced a qualitatively different period in the development of the given science. That is why it seems to us that the concept of paradigm brought forward by Professor T. S. Kuhn can not be utilized for

constructing the periodization in the history of science, still much less in the history of technology.

The creation of a new design, the invention of a new machine are not to be regarded as the commencement of a new period since technology does matter only when it has found a practical application, this meaning however not simply application, but a wide expansion as well. Furthermore we will shortly dwell on our ideas regarding the periodization in the field of the history of technology. That question was analysed by us more precisely in our book *The Foundations of the History of Technology*¹.

It is first of all necessary to dwell on the question what sort of principles are to be applied when choosing the periodization in the works concerned with the universal history of technology. That question is one of the mootest and — as Professor Olszewski rightly pointed it out — one of the most complex since “the distinguishing of qualitative changes characterizing the whole of science and of technology is far more difficult”.

The experience of creating a *History of Technology*² shows that it is possible to find a periodization explaining with scientific validity the development of technology as a whole. It is notorious that the fundamental thing in the development of human society is the production of material wealth. Technology is being created and applied just for that very purpose. That is why — when choosing the basis for the division of the universal history of technology into qualitatively different periods — one must proceed from the fact that the technological epochs divide after the means of labour made use of by men. We consider it proper therefore to take the instruments of labour and the kind of energy most widely spread at a given period as a basis for the periodization. In proceeding from those considerations, we have divided the development of universal technology into seven periods³.

True, people may retort — as the author of the lecture does — that “the development of production tools, and thus the technological progress, precedes changes in economic and social relations, the former being the main factor to provoke those changes”. As a matter of fact, the historical materialism teaches that the productive forces (as well as their element — technology) of a subsequent period begin arising and forming still in the previous period. However, they do not yet determine that period, they intensify the contradictions and evidence that the relations of production do not correspond to the character of productive

¹ С. В. Шухардин, *Основы истории техники*. Москва 1961, pp. 99—148.

² 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 Compare the contribution of Professor Zvorykine to the discussion on periodization during this Symposium.

forces. It is only after the victory of the new economic basis that conditions arise in which the new technology can be made use of on a large scale.

Accordingly, in the aforesaid book *History of Technology* we have singled out into special chapters those inventions and discoveries that had become a basis for the technological progress in the following period of the development of technology, but did not play any decisive role within the stretch of time under review. Thus, for instance, the period ranging from the end of the XVIIIth century to the seventies of the XIXth century was characterized by the following important inventions: the first combustion engines, the Bessemer and Martin processes of steel manufacture, the discoveries in the field of electricity, and so on. In the space of time ranging from the seventies of the XIXth century up to 1917 there were invented: the aeroplane, the radio, the telephone and others. These inventions however did not determine the technology of the period in question, but they underlie the technological progress of our time.

Great emphasis has been put in Professor Olszewski's lecture on the working out of the periodization for works concerned with the history of particular domains of technology. One may fully agree to the lecturer's statement that "the new technology arises when the precedent one has attained best technical and economic indices, i.e. when it loses the possibilities of further development". By way of illustration, the author points out the development of the iron metallurgy. Professor Olszewski however does not speak about what is to be taken as the beginning and the end of each period. In what historical period, for instance, was being employed the blast furnace working on charcoal and water energy? To determine such chronological landmarks is just the hardest thing.

We are of the opinion that the vast employment of determined technological means in production, and not the first practical realization, is to be regarded as the beginning of a new period in the development of a particular domain of technology. In other words, the very moment in which the specific weight of the new technology within the production has grown considerably is to be regarded as the beginning of a new period.

When establishing the periodization of the energetics, the following question would be in place: what kind of period is being gone through by the present-day energetics — a complex one or an atomic one (according to the periodization of Professor Konfederatov⁴)? I believe that the peculiarity of the present-day energetics consists in the priority

⁴ Compare: И. Я. Конфедератов, *К вопросу о периодизации истории техники* (I. J. Konfederatov, *To the Problem of Periodization of History of Technology*). "Вопросы Истории Естествознания и Техники" ("Problems of History of Science and Technology"), vol. 4, 1957.

use of thermal and hydraulic energy as a primary one, and of the electric energy as a secondary one, owing to which the period itself has received the name of complex energetics. However, the atomic energy, although in use, does not yet determine the power balance.

We will try, at last, to examine the problems connected with the establishment of periodization when studying the history of particular technological means (instruments of labour, machines, working methods a.s.f.). In order to clearly represent the principles to be assumed as a basis for choosing the periodization, let us examine first of all the stages of transition from the old technology to the new one, the stages of creation of particular machines or working methods. As is generally known, technology is constantly transformed, it does not stand still, there goes on the process of replacing the old technology by a new one, and the new one — by a newest one. Without that, the production of material wealth cannot subsist nor develop.

In the production process men are being confronted with such or other technological problems, the solution of which involves the invention of various machines, ways or methods of work. Technology, just as other natural and social phenomena, is characterized by internal contradictions, the elimination of which leads, on the one hand, to the perfection of technological means being used at a given moment, and on the other hand, to the invention of new machines. Every machine, instrument of labour, way or method of work have their positive and negative aspects, their shortcomings which restrain the raising of labour productivity as well as the attainment of better parameters, and which do not ensure a full working safety nor a high quality of production. The development of technology is bound up with a constant and uninterrupted elimination of those shortcomings in search of ever new solutions for the technological problem raised.

How is going on, however, the replacement of the old technology by the new one, what kind of cycle is possible here? At first, on the basis of a long experience of men and as a result of employing the previously discovered laws of nature, a new principle for solving one or another technological task is being suggested. There follows the elaboration of the design of machine, of instruments of labour, the creation of production technology. At times, there are simultaneously worked out the theoretical foundations of a given question. Thereupon, the experimental pattern is being tested, at first in laboratory conditions, and then by industry itself. On finding the tests to be successful and after eliminating the revealed shortcomings, the design is being elaborated and introduced into production.

The beginning of the introduction of the new technology is characterized by the fact that in the said period a coexistence between the new technology and the old one is taking place, the new technology

being still in germ, the old one however occupying a dominant position and carrying a considerable weight within the production. The new technology is being introduced in an obstinate struggle between the new and the old.

But the new, the advanced, the progressive has to gain victory over the old, the outliving. So it is; the new technology at last supplants the old one. Men realize both technical and economic merits of that new technology. From that very day a new developmental period of the given technological means begins — the period of their employing in production.

In the process of that employment the new technology is being more and more perfected and modernized. How is the beginning of that new period in the development of technology to be determined? A great role should be played by quantitative data showing the specific weight of the new technology in production.

It must be borne in mind that at the very time when the replacement of the old technology by the new one is going on (and this can sometimes be a question of a rather long period) and when the old means and the new ones have approximately equal technical parameters and yield analogous results, it is the economic considerations that are the fundamental criterion for choosing one or another type of machine.

Later on, after the new technological means have been perfected, the experience of operation accumulated, and the production technology improved, there occurs a definitive extrusion of the old technological means.

The victory of the new technology over the old one does not mean that the former no longer develops; on the contrary, the introduction of the new technology into production fosters the elimination of the existent shortcomings and the former's rapid perfection. Without altering the principle, people achieve the improvement of all parameters of the new technology employed. Subsequently however even this new technology is no more capable of satisfying the needs of production, its possibilities are becoming exhausted. There begins the cycle of the new technology being replaced by the newest one. It is to be noted that the new technology is being replaced by the newest one at a moment when the former has reached the peak of its development.

Thus, the machines, the instruments of labour, the ways and methods of work go in their development through the following periods: the birth of the idea, the working out of the first design (method), the testing of the first patterns, the bringing of the design to the state of efficiency, its introducing into production, the vast employment in production, the replacement by a new technology. True, this is only a general scheme of the development of technological means; when studying the concrete domains of technology, the said scheme can be subject to some alterations.