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An end to progress?

1. The end of the future?

The word 'future' has had optimistic connotations in our culture ever since early modern times. When understanding ourselves as "in development," we expect a better, truer, and more essential being in the future. 'Future' means the open frontier of the world, the direction in which man can evolve infinitely, the affluent field of opportunities. When thinking about the future, one feels liberated, fantasy is freed from the restrictions of the reality principle. Although we still experience this liberating impulse when thinking about the future, we are also disturbed; not only the principle of hope, but also the principle of anxiety structures our ideas about the future. Utopias, depictions of a better world, are now balanced by "dystopias," visions of catastrophes to come.

Today we can talk about the future in a reasonable way only when — paradoxically — we dare to think this future might not even happen. Speculation about future developments is more or less explicitly modified by the presupposition that it will not end in nuclear holocaust. However, this reference to the possibility of a dead-end is flat and irreflexive, for the notion of "peace as a precondition of the scientific-technological world"[1] is seen only as a border condition which does not modify our speculation about possible developments, for example in physics, technology, or society. However, the unreflective continuation of partial developments may be exactly what precludes the precondition of this continuation — namely, that a third world war will not occur. Hence, another type of apocalyptic thinking should intrude into our thought about the future: we should consider an end to history not in the sense of a finalization but in the sense of a termination of the accepted patterns of development.

This idea of termination causes some fear and mobilizes a defensive attitude. Although this effect may not be expected, it will appear plausible after some further comment. When the idea of an infinite universe arose in early modern times, it was welcomed by a very few persons, e.g. Giordano Bruno. For most people it meant metaphysical irritation since they were deprived of their accustomed horizon of a finite

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cosmos, and thus were submerged in a gulf of diffuse anxieties. Today, the situation is quite opposite: what frightens us is the idea that we might be forced to accept a finite world, i.e., a world without economic growth, scientific-technological innovation, or new resources. Obviously the idea of progress implies a tendency to run away — away from the present. This connection is well-known when applied to economic growth: economic growth relieves the conflict between labor and capital.

I would like to illustrate my claims that transformation in the pattern of development causes anxieties with an example that is particularly close to us scientists, namely, scientific development. When my colleagues and I from the Starnberg Max Plank Institute published our theory of the finalization of science (Böhme et al., 1976: 307—330), we experienced some fierce political and emotional opposition.[2] This opposition was partly the result of a certain misunderstanding of our terminology. Whereas we intended 'finalization' to mean goal orientation in scientific development, our opponents understood us to be announcing the end of science. Admittedly, they were not completely mistaken, for our theory actually implied that the number of fundamental problems within a particular scientific realm was finite. It is this idea which provokes resistance; it touches a nerve of scientific self-conception, according to which one is engaged in a process of unlimited progress. As to this self-conception of science, I would like to refer to a sentence of Popper's which was brought forward against our theory: "With each step taken forward, with each problem that we solve, we discover not only new and unsolved problems, but we discover also that where the ground upon which we stand was believed to be firm and certain, in truth everything is conceived of as uncertain and as vacillating" (Popper, 1971: 163). This self-conception comprises some ideological elements because it serves to legitimate the need for scientists forever. Modern scientists conceive of themselves as researchers, and hence the prospect that some day nothing might be researchable causes anxiety. At the same time this point sheds some light on the paradoxical resistance to the ideal of truth in science. Although the search for truth is the understood motive of science, the possibility of arriving at truth is banned from the dominating theory of science. At the time of the finalization debate, we ironically termed this theory a "hydra-theory" of science — each question answered by science engenders some new unanswered questions. However, can we not imagine that the historical job of science might be done some day? We have to raise questions such as this one to sustain the irritation connected with them without anxiety. The fear of great catastrophes is the suppressed fear of changing our life patterns — one wants to continue as usual, and thus one runs the risk of the great explosion at the end.

2. The concept of progress

It is central to the patterns of development that determine our lives that human history implies progress. An example showing that this relation is conceived as something natural or even logical is the argument for increased armament. It is quite natural to modernize one's weapons. Clearly, one cannot be well equipped with the arms of yeasterday for the war of tomorrow. However, the idea of progress is not a very old one in human history. The philosopher Karl Löwith eventually called progress the characteristic of merely a certain period in the history of humankind. Granted, even in antiquity there were some ideas about improvement and progress in different fields; still that does not mean that humankind was understood as evolving into an infinite horizon of open possibilities. For example, Plato tells a myth of progress in his dialogue *Politicos,* but this myth remains within the framework of an understanding of history as cyclical. Plato draws an ambivalent picture of human progress; it consists of a pair of divergent lines. On the one hand, science and technical competence become ever more efficient; on the other hand, there is a degradation of ethics and a loss of immediacy. This, according to Plato, must in the long run lead to unbearable conditions —

so much so that one day God must interfere and turn back the wheel of history.

The interpretation of history as cyclical was fundamental until the Renaissance. This pattern of thinking included a certain concept of progress, but at that time progress always implied the advancement of humankind toward an ideal state that had been realized once before during the golden age. This meant that progress was never conceived of as infinite enhancement, but rather as the attempt to return to an original state of completeness. According to the investigations of my colleague Wolf Krohn (Krohn, 1977), the modern idea of progress has two sources: one is the step-by-step improvement in artisanship and technology, the other is the humanistic idea of human development toward an ideal. Krohn denies that the theological notion of a history oriented toward salvation exerted any influence; but I think that it must be taken into account, for the concept of cyclical betterment held by the humanists had to be broken by a concept of linear time in order to form the modern idea of progress. However, another point of Krohn's theory seems important to me. He says that Francis Bacon and Descartes raised the understanding of progress as stemming from these sources to a meta-level; in other words, they made it the conscious principle of human history. According to Bacon and Descartes, what matters is that humankind achieves control over history by steadily striving for progress.

Summarizing this sketch of the emegence of progress, we can differentiate the following features. 1) The modern idea of progress implies an endless horizon in time. 2) Hence progress no longer means approaching a well known ideal of completeness, but finds its measure in the actual status quo. That is, progress becomes a dynamic principle — it is nothing but enhancement. 3) Thus the concept of progress contains a normative element; progress is the enhancement of what actually is. 4) The idea of progress becomes a principle of history. In other words, progress does not take place in particular dimensions but characterizes the development of humankind as a whole. 5) Artisanship and technology, and subsequently science, occupy leading positions in what constitutes progress for modernity.

I shall develop this last point somewhat further. Artisanship and technology initially provided the only clear and unquestionable examples of improvements, i.e., they offered the only examples of accumulation across time. The arts, rhetoric, and literature — comprising the proper field of humanism — experience losses as well as improvements and are thus characterized by their growing or shrinking distance from the ideal. Later, Bacon and Descartes designed science as a method of improving human conditions. In their eyes, science had to serve the improvement of human life through the mastery of nature. In addition, the scientific method had to provide a procedure for coping with social and human problems. This idea acquired some reality in the eighteenth century. Scientific method, understood as the procedure of analysis and synthesis, was effective as a principle of enlightenment. It caused a certain transparency, a liquification, and finally a liberalization of institutions. Keeping in mind this effect of science, we notice that our contemporary concept of progress is much more closely affiliated with the ideas of Bacon and Descartes than with those of Hegel and Marx, since the latter considered progress to be the penetration of human affairs by reason rather than scientific and technological improvement. When we raise the question whether progress as a pattern of human history may have come to an end, we are primarily concerned with science and technology: do science and technology promise endless progress? The next question — immediately prompted by the preceding one — is whether this progress will be connected with human progress.

3. Progress in science

In recent times, some voices — matched by supporting indications — have declared that scientific development may come to an end. To be sure, historical analysis tells us that

such voices have been heard time and again, e.g., around the middle of the nineteenth century and again at the beginning of our own,[3] but these facts should not make us disregard the debate about a possible end of science. Let me first give a catalogue of relevant considerations.

The first may seem trivial because it deals with the quantitative growth of science. Already in the early sixties Derek de Solla Price (1963) demonstrated that scientific growth is exponential, whatever measures of science you take (e.g., the number of articles published per year, the number of existing journals, the number of Ph.D. theses, the capacity of certain types of instruments). When these findings are compared with the possible resources in finance and manpower which are or may be available for science, it becomes clear that we have been in a critical phase for some time. Either scientific growth is running up against a wall (i.e., its over-complexity may no longer be manageable or its over-capacity may no longer be financeable) or scientific growth is slowing down drastically and will eventually resemble a logistic curve, which implies zero-growth in the long run. This has actually taken place during the last couple of years, and the transition turned out not to be catastrophic. Nevertheless, it was difficult in regard to the social and psychic situation of scientists.

However, the relevance of quantitative considerations may be questioned. What do they contribute to our question about whether science and technology may come to an end? One answer is that they account for the background of the "doomsday mood" connected with the end of growth. But we shall see later that quantitative considerations have wider implications.

A second consideration, the destruction of the belief in progress achieved by philosophy of science, should be mentioned. The leading philosophers of science originated this destruction of the belief in progress. Paradoxically, Popper is to be counted among the grave-diggers of the idea of progress. Did he not make growth of knowledge the central issue of philosophy of science? Science, according to Popper, is the endless process of improving hypotheses. Does this concept of science not include progress? Surely it does. However, since it neither acknowledges a footing in truth as a point of departure nor accepts a final arrival at truth, it comes as no surprise that in the aftermath of Popper's philosophy the image of science has been degraded to a mere network of hypotheses. When the generation of problems of science is finally considered as a merely internal process, as by Larry Laudan (1977), then science becomes nothing but a fantastic spider's web.

The other mode of destruction was initiated by Thomas Kuhn's book *The Structure of Scientific Revolutions* (Kuhn, 1962/1970). Kuhn's main attention was directed toward the fundamental revolutions in science. He has good evidence for his thesis that important scientific innovations do not simply enlarge the explanatory capacity of science but alter the world-view in general, which means that when new phenomena appear others disappear. Hence Kuhn himself stated that progress can no longer be considered as progress toward an end but only as progress away from an origin. This leads to a picture of science according to which each epoch is — as Ranke said — "equally distant to God." Thus science is on the same level as the arts. Nicholas Rescher drew precisely this conclusion:

> Today's major discoveries represent an overthrow of yesterday's: the big findings of science, it would appear, inevitably contradict its earlier big finding (in the absence of 'saving qualifications'). Significant scientific progress is generally a matter of not adding further facts — on the order of filling in a crossword puzzle — but changing the framework itself (Rescher, 1978: 48).

I would like to adduce a third consideration, namely that of those voices coming from inside science, telling us that natural science in various domains — and perhaps as a whole — is nearing its final problems. Not surprisingly, very successful scientists repeatedly get the impression that the fundamental problems of

their equally successful disciplines have been solved or will be solved very soon. Admittedly, this very often happens to be a mere confusion between biography and history. However, arguments are sometimes brought to bear. A case in point is Gunter Stent's book *The coming of the Golden Age*. According to Stent, an end to research may be expected in a discipline when the task is limited by its subject matter. I quote from Stent's book:

> I think everyone will readily agree that there are *some* scientific disciplines which, by reason of the phenomena to which they purport to address themselves, are *bounded*. Geography, for instance, is bounded because its goal of describing the features of the Earth is clearly limited. And, as I hope to have shown in the preceding chapters, genetics is not only bounded, but its goal of understanding the mechanism of transmission of hereditary information *has*, in fact, been all but reached (Stent, 1969: 111).

This argument — if there is a definite task, it can be solved accordingly — is compelling but does not say much about science as a whole.

On the other hand, there are arguments that hold that the project of science as a whole may be limited. One such argument has been brought forward by von Weizsäcker (1971/1980). Von Weizsäcker points out that the great branches of science such as physcis, chemistry, and biology exhibit a tendency to grow together, and that they increasingly build upon one and the same ground. This historical fact is connected by von Weizsäcker with the Kantian idea that the true grounds of science are the conditions of the possibility of experience in general. This idea, in turn, is tied to the observation that a theory of elementary particles or fundamental forces seems to become the basis of all scientific theories. What surpasses this idea is of yet only programmatic significance, namely the project to develop a theory of elementary particles from general considerations about the necessary preconditions of experience. Von Weizsäcker's theory may be called a merely speculative one, but it is precisely its programmatic character which makes it superior to mere arguing about the eventual completion of science: it points to a way in which this completion can be achieved. I shall come back to this position later. But here I should add that the position in question is strongly opposed to the Popperian or Kuhnian understanding of science because it quite naturally implies that scientific questions can be given definitive answers.

The last part of this section will be devoted to Rescher's previously mentioned book, *Scientific Progress*, which may be considered to have set a standard for our present concern. Because of its brilliant argument and nearly comprehensive discussion of divergent positions, it provides an indispensable basis for further discussions of scientific progress.

Rescher takes it for granted that economically science has to live with zero-growth. From this point of departure, he infers as a general trend a logarithmic decrease in the production of important scientific results:

> A simple but far reaching *idée maîtresse* lies at the basis of these deliberations: the thought that if it requires (as over the past century or so it has) an exponentially increasing effort to maintain a relatively stable pace of scientific progress, then in a zero-growth era of constant effort science will enter a period of logarithmic deceleration (Rescher, 1978: 2).

The decisive middle term of his argument apparently is the claim to "diminishing returns" in science, i.e., inversely the contention that continually increasing effort is necessary for obtaining comparably important results or breakthroughs. Empirically, this argument is neatly warranted by the fact that the expenditures for basic research in natural science have grown exponentially during the last few decades. It seems questionable, however, whether really important breakthrough and new phenomena can be obtained merely by attaining to new dimensions. This claim obviously rests on a

qualitative estimation of results. But one may concede this to Rescher: he tries to find a more fundamental basis for his argument by the quasi-ontological supposition of levels within nature that follow logarithmic scales.

Summarizing Rescher's argument, it seems to be nothing but an over-sophisticated explication of the qualitative impression many of us share, namely, that during the past decades steps toward solving fundamental problems could be made only with ever growing expenditures of manpower, apparatus and money.

Rescher' conclusion: there is no end to science, but only a deceleration of scientific progress. However at this point an important difference emerges, namely between synthetic and analytic problems. Rescher calls problems synthetic or power intensive if they can be overcome only with a compact effort. Examples provided are investigations undertaken in extremely small or extremely large dimensions, e.g., in particle physics and astrophysics. By contrast, analytical problems are problems of complexity that can be solved, as Rescher puts it, "in installments." The exponential expenditures necessary here need not be provided all at once, but could be dispensed over time. Analytical problems are to be found in biology and medicine. As for synthetic problems, Rescher does expect actual limits to science set by the limits of accessible support. But for analytic problems he looks forward to endless progress. Rescher thus thinks that a shift is taking place in science, a shift from fundamental problems to problems of complexity.[5]

Evaluating Rescher's argument within its own framework, one may come to the conclusion that it is self-defeating: on several occasions (e.g., on p. 53) he declares that the motive for writing his book was to stimulate society to maintain a steady effort in science. However, what actually follows from his argument is that really important results will become ever rarer. This insight will of necessity diminish the legitimation of the still considerable expenditures for science, and — what may be of greater consequence — it will discourage bright young people from becoming scientists. Consequently, an additional factor will contribute to the decrease in the rate of scientifically important findings.

However, we should also evaluate Rescher's argument with respect to considerations that did not come to his attention. As the preceding quotation revealed, Rescher is extremely Popperian: in his view, the only unquestionable dimension of progress in science lies in the instrumental domination of nature. He thus dwells upon a rather naive concept of progress. He not only takes the dialectic of the domination of nature into account, but also adheres to the vision of man's capturing larger and larger dimensions and smaller and smaller particles, his entering the realms of shorter and shorter periods and deeper and deeper temperatures, etc. However, if there is no real progress toward truth, all scientific progress (i.e., progress qua domination of nature) must be considered rathet ambivalent.

Rescher, on the one hand, does not know von Weizsäcker's argument, and on the other hand, in true Popperian fashion, is always oriented toward the esoteric frontiers of science. In other words, he does not care about what has been left behind — the classical theories, for example.[6] If we take these arguments and facts into consideration, Rescher's results appear in a different light. It is possible that in a time to come the basic questions of science will be answered — at least to the extent that they are questions concerning the fundamental building blocks of nature and inasmuch as these ultimate constituents can be experimentally identified and have practical value for humankind. Then we would have "closed theories" at our disposal, each of which would describe nature at a certain level of magnitude. Science — in full agreement with Rescher — would not have come to its end but would only develop in the direction of growing complexity. Then phenomena, natural processes with some practical impact on humankind as well as technically produced ones, would constitute the very field of research. Insofar as scientists would not set their hearts on investigating the colors of butterfly wings (Allison), technical problems (or problems engendered by technology) would provide the

main subject-matter of science. Thus the question of the future of science shifts to the question of the future of techniques and technology.

4. An end to progress by science and technology?

As far as technology is concerned there is no indication of an end or, on a certain level, even of a saturation. One reason is that in technology one essentially moves toward constructive complexity in the development of the world, a complexity for which there is no plausible limit. In addition the technical potential of scientific knowledge is by no means exhausted. On the contrary some qualitative leaps may be expected from the solution of the remaining fundamental questions. There is no reasonable foresight in technology, only science fiction. To my mind there is only one possible end to technological growth — which may be illustrated by the story of Babel's tower. The technical transformation of the world is indeed akin to the building of the tower of Babel. The construction of the tower, the Bible tells us, was brought to a standstill by a confusion of languages. However, paintings such as Althofer's suggest another interpretation: namely that one day the construction of the tower could not proceed any further because all of the manpower was already needed for repair. Our present second nature, the technical environment in which we live, is for the most part a heritage of our ancestors. This second nature in our time already consumes so much manpower and other resources for its reconstruction that one may imagine that some day in the future enlargement will no longer be possible. However — and at this point technical imagination again comes into play — it might be possible to develop self-reproducing technical systems. Biotechnology, the next clue to technology to come, might be a step in this direction.

If there are any doubts concerning progress in technology or in the whole complex of science and technology, these doubts do not concern the possibility of some further development; rather, they question whether technological progress has produced human progress. These doubts bear on the Baconian program, its legitimacy and its feasibility. Although the actual enhancement of human life through science and technology must not be contested, doubts nevertheless arise when we observe that enhancements have meant deteriorations at the same time — that gains have been connected with losses. The fascinating improvement in control over nature at the same time has brought a frightening increase in man's power to destroy. Looking more closely, we must even say that the type of domination of nature which is provided by science and technology is more akin to destruction than conservation. Its manner of thinking — causal, linear, elementary — is much more capable of destroying a system than of keeping it alive.

The project of death is much easier to fulfill than the project of health. Let us take modern medicine as an example. The eminent achievements of scientific and technical medicine must not be denied. But they have not enhanced the average health of man. On the one hand, they have simply caused a quantitative shift among the different illnesses; on the other hand, they have contributed to the proliferation of exactly those diseases which they were able to treat, for instance, diabetes. The reduction in mother and pre-natal mortality did not improve the state of humankind as a whole. The well-being of some people has again been paid for by the unfortunate fate of others, who die of starvation and poverty. The extreme contemporary development of scientific and technological knowledge at the same time proves to be a huge process of unlearning as well as a devastation of non-scientific modes of knowledge. This has disabled the average man from being master of his life, and increased his dependence on experts. It is not even true that the work of the individual has been reduced by technical equipment. Indeed, what has been saved by technical means must be expended to provide for those very means. The car is a case in point[7]: what the men and women of our century save in labor-time they lose by the prolongation

in traffic time. What may be saved in time for the preparation of meals at home, must be paid for by a prolongation in shopping time. These are some examples of the ambivalence of technical achievements. Assuredly, one may wonder whether it is only the present "incomplete" state of our technology that reveals such ambivalence. Analysing our contemporary technical thinking, we may discern deficiencies in it that suggest a different kind of technology. For example, the differentiation into the effects and side-effects of drugs is extremely short-sighted since it is biased by the appliers' interests. In reality — namely at the level of the effects — there is no such difference. In addition to that, it is quite obvious that linear and elementary ways of thinking are not appropriate for complex systems. It is also clear that a technology which treats nature as a mere stockpile of raw materials fails to make use of and even destroys its reproductive forces. Consequently, the reproduction of the system in question will have to draw on human labor. Criticism of that sort may lead to a new technology. Today, however, we must say that the dominant technology no longer supports the hope for human progress.

The last statement might lead to our demanding an end to technological progress. In domains such as weapons technology, this in fact seems to be the appropriate demand. But I do not believe that the development of technology can be affected by moral demands. The motive forces for this development are to be found in economic conditions or, as is shown by the case of arms technology, in international power relations. Before claiming a new technology, one should envisage the truth that the technology that is ours and that determines our lives does not improve the human condition.

The question today is not how we can solve our problems by the application of technology, but how we can live in human dignity *under the conditions* of technology. Science and technology are no longer the means we can use to achieve this or that purpose, they are rather the boundary conditions of human life; they do not consist of individual insights or instrumentally useable things or apparatus but form a basic pattern of our existence. Our way of living is not better than a pre-technical one, it is simply different. It implies other dangers and hopes, other modes of living and dying, other kinds of illness and health, other sorrows and joys.

Indeed, I believe that we have come to an end of progress, which means the end of an illusion concerning humanity's way toward betterment. The shattering of this illusion should not lead to lamentation, but should instead provide the occasion to consider what human life under technical conditions is and what particular opportunities it harbors.

NOTES

1. I owe this formulation to Carl Friedrich von Weizsäcker.
2. See the bibliography concerning the debate about finalization in the book edited by Schäfer (1983).
3. See the documentation furnished by Rescher (1978).
4. Unfortunately, von Weizsäcker's positions do not seem to be known to Rescher.
5. Incidentally, we state the same conclusion in our original paper on the question of finalization (Böhme et al., 1976).
6. As for classical theories, see my article "On the Possiblity of Closed Theories" (Böhme, 1980).
7. This point is nicely illustrated in Ivan Illich's Energy and Equity (Illich, 1974) — in particular see chapter VIII, which is a plea for the bicycle.

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