Back to Contents
Next to Chapter 11

Chapter 10

Is a Scientific Approach to the Eschatological Problem Possible?

A Logical Analysis of the Problem of Global Ecology[1]

For there shall be days when you will say:
Blessed is the womb which has not conceived,
and those breasts which have not given suck.
APOCRYPHAL GOSPEL OF ST. THOMAS

Oh man? why is the world becoming so small
for you? You want to possess it alone; but
if you had possessed it, it would not have
been spacious enough for you; . . . ah, this
is the pride of the devil who has fallen from
heaven into hell.
JACOB BÖHME

Introduction

In recent years, the ecological problem has acquired apocalyptic overtones. To solve this problem, science must not only study a phenomenon, but must also learn to predict its evolution on a large time-scale. Furthermore, the solution to the ecological problem cannot but change the direction of our cultural progress. Never before has science been faced with problems of such global significance. Is it ready to solve them? To answer this question we must understand whether scientific forecasting is possible, whether scientific ideas can influence social behavior, whether

[1] This chapter was translated by A. V. Yarkho.

the historical origin of this crisis can be scientifically analyzed, whether a scientific approach to setting a global goal is possible. Below I shall not try to answer these questions but only to discuss them. The problem is so serious that it should be discussed freely and objectively.

My sole aim is to demonstrate that *there may be another approach to the problem, different from the existing one.* This chapter is written in an axiomatic-narrative style. Illustrations and arguments serve to elucidate the axiomatic statements. It is not my purpose to prove anything or to convince the reader. It is up to the reader to regard my approach as legitimate or not on the basis of his own experience and on the facts as he knows them.

Logical Analysis of the Problem of Forecasting[2]

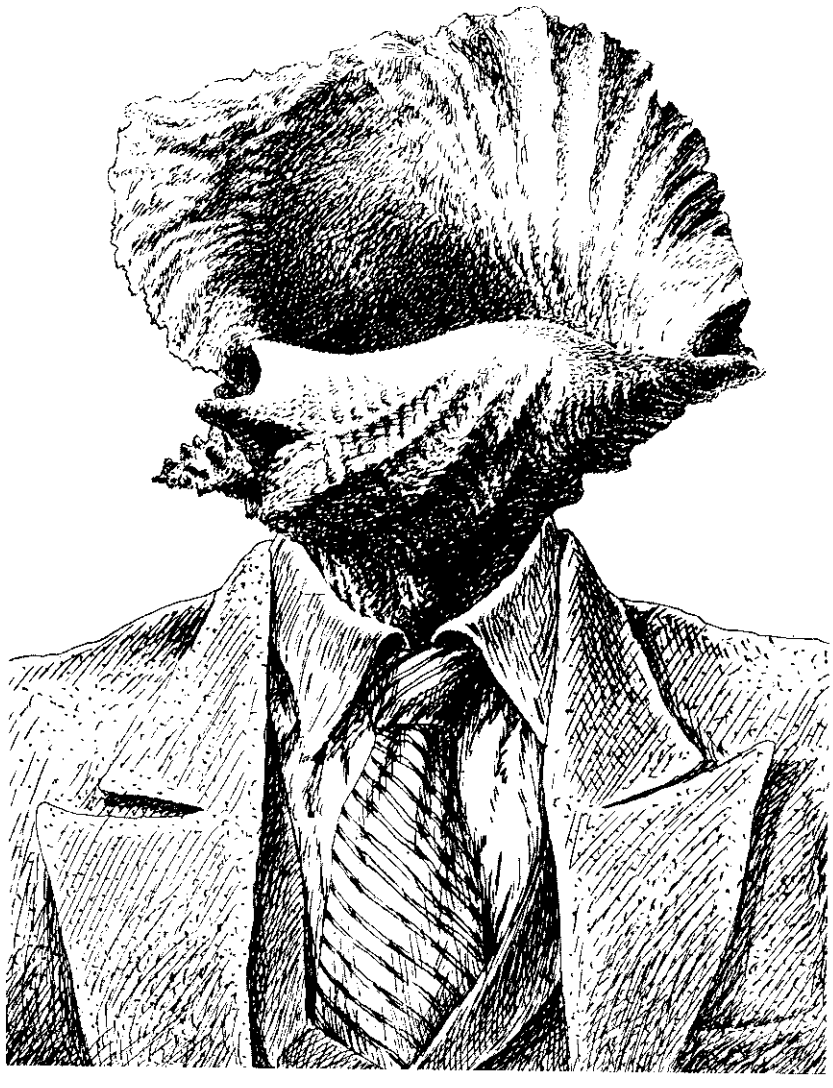
Soothsayers.
As lower down my sight descended on them,
Wondrously each one seemed to be distorted,
From chin to the beginning of the chest;
For tow'rds the reins the countenance was turned
And backward it behoved them to advance,
As to look forward had been taken from them.
THE DIVINE COMEDY

We have suddenly become aware of the threatening aspect of the ecological crisis as a result of the forecasting of its future development. Therefore, it seems natural to start our discussion with a logical analysis of forecasting.

Formally, forecasting is nothing more than extrapolation. However, we do hope to get precise and definite ideas of the future on the basis of fairly vague notions of the mechanisms which have been operating in the past.

Is scientific forecasting of this type possible? Strictly speaking, the answer is no. In the natural sciences, only those constructions are considered scientific which can be verified by experiment. Here lies the demarcation line between scientific knowledge and non-scientific constructions. This is not "positivism" but the standpoint of a naturalist, which determines his everyday life. All of us are well aware of the difficulties connected with a formal definition of what constitutes the experimental testing of a hypothesis. Verification is logically inept. Falsification, in the terms of Popper, is logically clear but far from universally applicable. One could describe numerous natural scientific construc-

[2] This section was published in part in the journal *Znanie-sila* (no. 1, 1972).



Logical Analysis of the Ecological Problem

tions which have not been tested by falsification. The American study mentioned earlier is an ecological illustration. An extensive study of five large ecosystems (the steppe, the tundra, etc.) was carried out, and mathematical models were built that included up to 1,000 parameters. In building the models, experimental data were used, but the model as a whole could not be subjected to direct experimental testing. Thus, as

mentioned above in the context of statistical inference and its problems, these models do not inspire confidence (Mitchell et al., 1976). In forecasting, the comparison with reality can be made only at the moment when the prediction comes true. At the time of its formulation, it cannot be tested and, therefore, in its most general form, it has no scientific status. Nonetheless, everybody is making forecasts: industrial firms, think tanks, and the Pentagon, as well as sciencemetrists, economists, and sociologists.

Here I consider the following questions: In what way is forecasting possible? When does it become scientific? The rest of this section is devoted to what I consider to be the facts concerning forecasting.[3]

1. Deterministic forecasting is possible if we are dealing with an isolated phenomenon whose mechanism is known, and if the forecast is made for a period during which the system that encompasses the phenomenon in question will remain stable. Celestial mechanics can serve as an illustration. However, here, too, initial conditions are given with uncertainty, and everything must be recalculated from time to time.

2. A type of forecasting is widely used in engineering. When designing a bridge, an engineer forecasts its strength for decades. He proceeds from his knowledge of metals and their properties, the resistance of materials, and the statistics of constructions, and he assumes that no natural catastrophe will occur for several decades. Even though he knows his calculations are quite accurate, the engineer insures himself by going beyond the data obtained. He adds in a safety factor in a way which would be impossible for an economist or a sociologist.

3. For the contemporary scientific community, forecasting is both possible and impossible. At present we clearly see the revolutionary nature of scientific development (Popper, Kuhn). From time to time, scientific concepts are formulated which have the characteristics of programs of experimental research and predict new effects. In their moment of decline, old concepts are exhausted and hinder further progress. This has been discussed in numerous works (e.g., Barber, 1961; Popper, 1972; Duncan, 1974; Garfield, 1977).[4] But can one speak of forecasting even in moments of revolutionary development? The future is not scooped from the past, as it should be, according to the meaning of the concept of forecasting. There is a carnival of new ideas. One can speak of conjectures, of insight, but in no way of forecasting.

[3] I would like to draw the reader's attention to a paper by Taylor (1977) in which the possibility of forecasting social changes is considered with a critical eye.

[4] The last paper gives a dramatic account of scientific forecasts for flying machines. There were favorable predictions by non-scientists, and very unfavorable ones too. One such unfavorable prediction was made by Newcomb, an outstanding mathematician and astronomer, in the days when the first experiment with an apparatus heavier than air was carried out. (The text of Newcomb's article is given as an appendix to Garfield's paper.)

4. From all that has been said above, the absurd nature of forecasts based on expert estimates becomes evident. Which expert should one prefer: a representative of the orthodox majority who support the established paradigm, or a member of the minority who seek new ways? Are there means to distinguish new sprouts from the weeds which always accompany the growth of science?

5. Supporters of forecasting will claim that there are numerous examples of successful forecasts of gross social phenomena. Such examples do in fact exist. One of them, which is quite amazing, is given in the first epigraph to this chapter. Others, almost as amazing as this one, were made by Nostradamus[5] (Leoni, 1961). Scientists sometimes make forecasts of the same power. In what way do they differ from the non-scientific forecasts quoted above? Does the difference lie in the non-scientific character of their arguments? If the forecasts *were* scientific from the standpoint of natural scientists, why did not all scientists accept them, and why did not other scientists learn to forecast on a scientific basis so as to be able to forecast the catastrophic manifestations of our contemporary culture?

6. Marxism, despite its popularity, did not generate mathematical models which would forecast social development unambiguously and in detail. The enthusiasm of American scientists for mathematical models of the economy proved to be ill-founded, as is stated by Leontief (1971), the originator of the trend. And if one wishes to speak seriously of social development, he would have to agree that we can be certain only of its spontaneous nature. In other words, it is impossible to write an algorithm for all aspects of social development, although this is not a conclusion accepted today. I could also speak of the general impossibility of this task, but this would take us too far from the main theme. If the state of matters is such, it would seem natural to resort to probabilistic methods. But the processes under consideration are nonstationary, random ones, and there is no strict mathematical theory for forecasting nonstationary processes. There have have many attempts to solve the problem heuristically (e.g., Box and Jenkins, 1975), but they are unconvincing. Thus, it is possible to speak only of short-term forecasts, not that these do not have immense local importance, especially in Western countries. The situation there is such that the pollution fines are very high, and at the same time, firms try to keep close to the upper bound;

[5] Nostradamus (1503–1566) was a physician and astrologer. His "Centuries" are forecasts written in the form of imaginary travels in the future destinies of mankind. Here is one quatrain which came true during World War II: "The Church of God will be persecuted. / And the holy Temples will be plundered. / The child will put his mother out in her shirt, / Arabs will be allied with the Poles." The translator of the Russian edition interpreted the last line in the light of events related to the Six Day War. This interpretation is, though arbitrary, possible, and it seems nothing better can be done in the interpretation of forecasts.

otherwise technology becomes very expensive. So the situation requires forecasting the consequences of spontaneous technical deviations due to the aging of equipment, uncontrollable change in the quality of raw material, change of meteorological conditions, etc.

7. From a purely psychological aspect, each person does constantly forecast some things. He forecasts his future when he takes a new job, gets married, or simply leaves home. We always live in two time scales. Physically, we live in a narrow, point-like interval of time, and mentally, in the sphere of consciousness, we live in the future and act for its sake. This bifurcation of our time scales is a noteworthy phenomenon of our culture; it is the source of inner disharmony. Such forecasts are always probabilistic (Feigenberg, 1972) and essentially personal. It seems pertinent to speak here of the field of initial concepts with a given distribution of probabilities and of a subjective, probabilistically given filter which reflects our system of preferences. To obtain the distribution of weights in the final forecast, one might use Bayes's theorem. The reasoning will be analogous to that in a later section where I discuss the probabilistic model of behavior. By the way, this may explain why the ancient Greeks, sober and rational as they were, consulted the Delphic Oracle and this introduced ambiguity into their decision making. They were well aware of the probabilistic character of predictions (Lifshitz, 1973), and the mysterious and solemn ritual might have stimulated the mechanism of probabilistic predictions by acting as a trigger. Thus, all this may not have been so absurd as it seems now.

8. *Negative* scientific forecasts are indubitably possible. Drawing curves of growth on the basis of the data of the past we may state with certainty what *cannot* happen if the rest of the system remains unchanged, and our statement will be mathematically grounded. About fifteen years ago, I constructed a curve of growth for the staff of a large research institute. The points perfectly fitted the exponent. The extrapolation showed that in 1980 the staff would reach 92,000!

My conclusion, therefore, is that *only negative scientific forecasts are possible, if any such forecasts are possible at all.* What has been said above is not a proof of this statement but merely an exposition.

The idea of an unavoidable ecological crisis is negative forecasting. The book by Meadows et al. (1972), in its negative part, is attractive for precisely this reason. Forecasts concerning the overcoming of the ecological crisis, no matter where they are written, seem to us utterly naive, and not because we do not believe in human creative potential. Any positive forecast presupposes transition to zero or almost zero rate of growth. The necessity for this is obvious. This, however, raises some questions. Is humanity, which lives within the paradigm of our culture, prepared for this radical and decisive step? If this step is made, where will it lead? Isn't

there a danger that society will lose its vital potential? Contemporary science is absolutely unprepared to answer these questions. Below I shall try at least to outline the related problems.

Comparative Study of Cultures as a Way to Understanding the Peculiarities of Our Behavior

Now it is natural to formulate the question: What is the source of the long-term process whose future end seems at present so gloomy? Is it the result of some unavoidable human qualities or a manifestation of specific aspects unique to our culture? While we remain within the framework of our culture, our behavior seems quite natural and the only possible one, but acquaintance with other cultures shows that this is not so. Here lies the significance and fascination of philosophical and comparative anthropology.

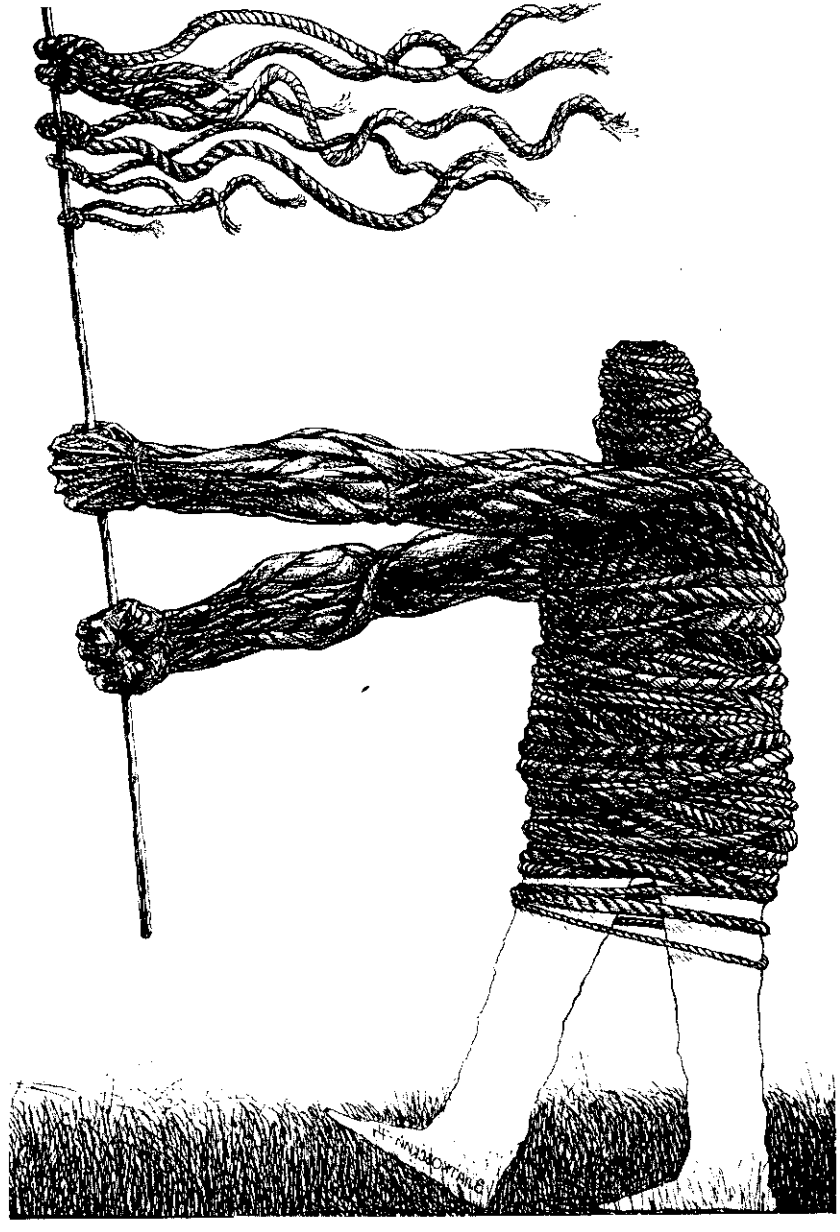
If we choose the way of comparative historical analysis, it becomes quite clear that the problem of global ecology is a logical fulfillment of the whole European *Weltanschauung*. Christianity followed the tradition whose roots lie in ancient Judaism and opposed man to Nature, directing him to prevail over Nature. In the first book of the Bible we read:

> And God blessed them, and God said unto them, Be fruitful, and multiply, and replenish the earth, and subdue it, and have dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth.

Hence it followed quite naturally that any society of Christian culture brought up on the Bible regards itself, while formulating its goals, as a formation independent of Nature and, moreover, dominating it. The idea of human superiority over nature deeply penetrated the consciousness of society and opened the way to the unrestrained development of technological civilization. These historical roots are now forgotten, and the idea of human domination over Nature becomes self-evident without regard to how any stratum of society relates to religion.

This becomes more explicit when we consider the traditions of the Indian culture (on the comparison of Indian and European cultures, see Nalimov and Barinova, 1974). The theory of Karma is a concept of a large system, and a human being is but a link in a long chain of events rooted in the remote past and related to the fates of all other living creatures. Here is how this is described by the Czech indologist Ivo Fisher (1969):

> Belief in the circulation of life presupposed the permanently repeated return of any live creature, any individual, to the Earth. A human



Scientific Approach to the Eschatological Problem

> being was thus made equal to all other creatures, and according to some schools, to the world of plants as well. He was only placed at a higher step of development in the framework of the whole process. He was in no way the master of Nature and of living creatures dependent on his will. Reincarnation was regarded as an eternal and immutable law which not only this world obeyed, but also everything living in the Universe. . . . This, of course, greatly influenced the private life of individuals and society, too. . . . Profound comprehension of the beauty of the surrounding world, amazing knowledge of the laws of the animal and vegetable kingdoms, and desire not to harm any manifestation of life were natural consequences of this idea. (p. 51)

We are, of course, far from believing that the solution of the ecological problem will be found by returning to ancient Indian concepts. In their system of views, for instance, certain difficulties connected with the impossibility of placing limitations on the birth rate become especially prominent. Another thing is important for us: the relativity and historical character of those initial premises of our cultures which, even in a cursory survey, seem inevitably human. Our culture goes deep into the past and it is not easy to liberate ourselves from it. Even to claim oneself to be an atheist is not enough.

If the historical analysis is to be continued, it is worth mentioning that Christianity, when fighting the paganism of the Northern peoples of the USSR, came across the belief that the pollution of Nature, the source of the life force for man, was a most profound offense. My father, who was an ethnologist studying the culture of Urgo-Finnish nationalities, often told me about this. He used to emphasize the elevated (toward the whole of nature) ethical tendency of pagan pantheism, which for a long time survived under the cover of Christianity among the people of Komi, which he, himself, came from. In the Western branch of Christianity, the friendly and loving attitude to Nature vividly displayed by Francis of Assisi was at first perceived as a heresy. Later, it entered catholicism, but only as an appendix. Could modern technological civilization have appeared if the prevailing outlook of society was close to the view of Francis of Assisi or of some nature-loving pagans? I do not think it could. The quotation from the Bible cited above opened the way to our scientific–technological progress which has led to the problem of global ecology that we face today. The life of peoples and their ideas endure through ages. For a long time, their sources remain unnoticed, so familiar and unavoidably human have they come to seem.

In conclusion, I would like to mention that G. S. Pomerants has drawn my attention to a paper by the British historian and moralist A. Toynbee (1972), "The Religious Background of the Present Environmental Studies," where the author develops ideas rather close to those set forth

above. In his discussion of the ideological sources of the ecological crisis, he, too, ascribes an extremely great significance to the admonition to dominate Nature which the Old Testament gave to European culture. In the conclusion he writes;

> If I am right in my diagnosis of mankind's present-day distress, the remedy lies in reverting from the Weltanschauung of monotheism to that of pantheism, which is older and was once universal.

In my opinion, the overcoming of the ecological crisis requires not a mere transition to almost zero rates of growth, but something more: a radical change in the human attitude toward Nature. This relates to some deep subconscious concepts of our culture. And how can a friendly attitude to nature be combined with limitations of the birth rate?

Dullness as an Index of the Quality of Culture[6]

Oh, thou heavy sorrow.
Deadly, wearying
Dullness.

A. BLOK

If overcoming the ecological crisis requires the creation of a new culture, this immediately suggests the following question: What is the index of the *quality* of a culture? One of the possible answers is that such an index is *dullness*! I am quite aware of the fact this is only a secondary social cateogory. However, I wish to analyze this very category. It is readily grasped, and human consciousness, both individual and collective, responds directly to this index, and not to the deep and obscure phenomena which generate it.

Modern Western society is to some extent protected from boredom by the variety of options available: by mass participation in the creative scientific process, by making careers, by stuffing one's house with a multitude of complicated modern conveniences, and by many other things. This all is carried out as a kind of game, which adds piquancy to life and makes one do his best.

However, this protection is not enough: boredom is coming to the fore, as is manifested by heavy drinking, drug addiction, unmotivated crimes, hippie-like movements that switch part of the young people off

[6] A brief version of this section was published in the collection of papers *Value Aspects of Natural Sciences*, Abstracts of the Reports of the Theoretical Conference of the Central Board of Philosophical Seminars of the USSR Academy of Sciences and Obninsk CPSU Town Committee, Obninsk, 1973, p. 79.

the main road of cultural evolution, and by senseless terrorism. Young people naturally respond to dullness most violently.

Almost all "game situations" in modern Western countries require comparatively high rates of growth, so what will happen if growth has to fall almost to zero? The loss of game situations, of pyschic distractions, is always a symptom of the crisis of a culture.

It would be of interest to analyze certain cultures of the remote past from this aspect. We know that there existed viable cultures with zero rates of growth—the so-called primitive cultures (a better name is ritual cultures) where society was protected from dullness by extraordinarily complicated ritual games. Now humanity has grown up, but the threatening question remains: Is it possible to create a culture with zero rates of growth which would protect society from dullness?

Probabilistic Model of Social Behavior

Discussion of the ecological crisis must naturally finish by discussing a model of human social behavior. This model should foresee the possibility of describing the behavior of a person in the unusual conditions which arise when the previous value systems change.

Nowakovskaya (1973) formulates the interesting idea that human behavior can be described in terms of linguistics. In my earlier books (Nalimov, 1974*b*, 1981), I used the Bayesian theorem to construct a probabilistic model of language which made it possible to explain both the general irregularity of language (word polymorphism) and its logical constituent. Now I am going to show how this model can be used to describe the motivations of human behavior. I do so in the following steps:

1. Human motivations are determined by the value concepts of a person.

2. Value is not a category of formal logic. Logic deals with estimating the truth (or falsity) of statements, but not their value. (In mathematical logic, there does exist a concept of the value of theorems, but this is only an estimation of their complexity.)

3. Something may acquire value if it can be correlated with the concept of a specific goal.

4. A truth, not correlated to anything, has no value.

5. The concept of goal should be formulated in a very concise way, so as to enable the construction of a value scale in the framework of this concept. Statements such as "a striving for survival" or "aspiring for the common good" are too vague and ambiguous to be the grounds for such a goal as, say, changing the human genetic structure. Hence, it is most

unlikely that a large-scale redirection of scientific research, with such a goal in mind, could ever come about.

6. The linking of goal and value is a metaconcept. Here is the formulation of this judgment by Wittgenstein (1963):

> The sense of the world must lie outside the world. In the world everything is as it is and happens as it does happen. In it there is no value—and if there were, it would be of no value (6.41).

7. The goal of the World may be cogently discussed by a metaobserver only if he is in a position to discuss judgments made in the object-language about the behavior of many different worlds or several versions of development of a single world. A metaobserver having at his disposal sufficient experience of the life of various worlds could also give a well-reasoned discussion of the question of changing the human genetic structure.

8. The same difficulty connected with the concept of goal is present in solving local problems. An optimal experimental design is a metastatement which proves possible when the statements about the experiment are formulated in the object-language. The latter, in its turn, becomes possible only after the experiment has been carried out. Here lies the paradox of experimental design—that branch of mathematical statistics which is concerned with choosing the best experimental designs. And it is due to this that the life of a researcher becomes exciting: he plays against Nature when he tries to guess how to choose the experimental strategy before the experimental results are known.

9. Pre-cybernetic science ignored the concept of goal. It was considered theological: a metaobserver is demiurge, the Creator of Worlds.

10. In the cybernetic system of ideas, a live organism is a self-organizing adaptational system capable of creating continuously (or sufficiently often) changing goals in the process of adaptation to the continuously changing world. These are metajudgments of an uncertain character; they are based on an insufficiently rich set of objective statements.

11. From the standpoint of a metaobserver, the development of an adaptation system will be regarded as a walk on a multi-extremal surface. As in the case of numerical methods for locating extrema, the system may become trapped in a logical ravine and perish. We know from history that some cultures, e.g., ancient Rome, perished because they were unable to change the direction of their development; other cultures, e.g., Japan and the Moslem East, managed to adapt themselves and survive under conditions outwardly quite alien to their initial conceptions.

12. A situation of the "Great Inquisitor" type when the goal is rigidly

set once and forever cannot serve either because this is not an adaptational structure but a demiurge-like one.

13. The development of society, even when influenced by science, may be viewed only as an adaptational walk along some local precipice since a rigidly given long-term goal does not and cannot exist.

14. Faith in a goal may spread in society like an infectious disease. The well-known mathematical models of epidemics may be used to describe this phenomenon. It is quite senseless to look for formally logical reasons for the appearance of a goal. At the moment of historical cataclysms, when masses of people rush forward to novel goals, the latter seem evident to all participants. Retrospectively, however, they often arouse our amazement, e.g., the Medieval Crusades. It seems possible that the generations to come after us will be surprised by the branch of modern culture where consumption is dominant and local optimization of everything turns into a goal; this is a case of means turning into a goal.

15. Goals may also spread epidemic-like in quiet periods of history. Let us consider this in somewhat greater detail. In the USSR, despite all protective measures directed against harmful ideas, complete success has not been achieved: smoking by young women, guitars, and the long hair of young men are hardly advocated by anybody, either explicitly or implicitly. They just happen. Of a similar spontaneous nature are the oscillations in the number of applicants to higher educational institutions: without any obvious reason, the number of applicants to schools of science and engineering decreases while that of applicants to humanistic faculties increases. If we now turn our attention to the West, we shall see that the movement of hippies—or, in the terms of Reich (1974), of the "third consciousness" of America—can well be described as an epidemic phenomenon. This movement even does without verbal argumentation: a fight with the Word, i.e., a contempt toward language, is one of the essential components of this ideology. Even the intellectual field created by science and scientific enlightenment does not hamper the spreading of irrational ideologies. As an illustration, consider fascism. Even scientists were seized by delirious ideas and in deadly earnest investigated such absurd problems as a military-technological application of the idea of a "concave Universe."

16. Now let us consider in detail what traits characterize the spreading of a disease epidemic: suddenness of occurrence; possibility of a latent state and awakening after a change in the external conditions (in the case of bacterial infections this may simply be a change of meteorological conditions); an incubation period without noticeable manifestations of outward symptoms and its passage to an active state, resulting in damage to vital centers of the organism or of society; a branching character of

spreading by way of transferring infection from one individual to another; self-exhaustion and decrease to zero values; creation of increased mutageneity, the means of resistance being present. One can notice that all these traits are characteristic not only for viral or bacterial infections but also for ideological ones. The peculiarity of socio-ideological infections is that they prove to be a specific response to stability or stagnation: society is afraid of boredom (as discussed above), and this fright represents a genetically built-in mechanism of its development. Here, probably, an analogy with immunity and the production of protective antibodies is pertinent; in society there are people, carriers of anti-ideas, who oppose the old ideas without generating new ones. Just as the creation of immunity necessitates the appearance of mutations in bacteria and viruses, the weariness from previous ideas gives rise to new directions of thought.

Many ideas may seem new, but after a thorough analysis they prove to be genetically related to ancient ones, and so the history of cultures might be regarded as paleontology of ideas. And if the appearance of new ideas as a response to boredom is considered a natural process, the impact of science on the social process should be directed not at the maintenance of social stability but rather at creating conditions favorable for generating wise changeability.

17. If a goal has arisen, the individual has to make decisions about actions on the basis of the system of postulates given by his value concepts. Here everything is complicated by the fact that postulates in the system of value concepts have different weights which do not remain constant in time. The process of decision making itself may be presented as a two-staged procedure. At the first stage one has to make a decision concerning the reconstruction of the system of postulates; old previously formed concepts (prejudices) must change under the effect of the ideas arising in deliberating the new goal, and this should be accompanied by renormalization, i.e., changing the weight of the postulates. At the second stage logical judgments are based upon a refined system of postulates, and the final decision or strategy of behavior is formulated.

In describing the former procedure, a Bayesian model is quite pertinent. As already mentioned, I earlier used the model to describe the way a man perceives a word on the basis of a field of its meanings. Separate fragments of the field are associated with the symbol-word in human consciousness with various probabilities. This probability is given by the prior distribution function of the word content. In the process of reading a particular concrete phrase, a new distribution function of the same word content is being built, already conditioned by the phrase; then, in accordance with the Bayesian theorem, a posterior distribution function is obtained that takes into account both the past and the new human ex-

perience. The essential feature here is re-normalization: what has been placed in the tail part of the prior distribution function may acquire a large weight after the new text is read.

Here again is the Bayesian theorem:

$$p(\mu|y) = kp(\mu)p(y|\mu)$$

When discussing the problem of value, we may ascribe the following meaning to the distribution function: $p(\mu)$ is a priori given (on a segment) distribution function of prejudices in achieving goals of type μ (these may be said to be weights of separate fragments of the value field appearing in achieving goals of type μ); $p(y|\mu)$ is a distribution function for value concepts that arise in deliberating the given concrete problem y, related to problems of type μ; $p(\mu|y)$ is a posterior distribution of values in the situation corresponding to the solution of the given problem; and k is a normalizing multiplier. In a continuous model, squares under the curves given by the functions in the right and left parts of the inequality must equal unity. The posterior distribution function turns into a prior one in solving the next problem of the same type. Below I illustrate the possibility of applying the Bayesian theorem with a concrete example, which needs certain preliminary explanations. It deals with the opposition of society and scientists themselves against new ideas. (I already spoke of this briefly in Chapter 1.)

The history of science is abundant with vivid examples of hindrances which became rather tragic as soon as they got the support of the state or such powerful institutions as the church. One can look back to Anaxagoras, the first materialist-physicist, who was accused of impiety; Socrates, who was put to death by an ignorant Athenian hoi polloi; Giordano Bruno, who, at the beginning of the Scientific Revolution, was burned at the stake by the Inquisition for advocating the plurality of Worlds; Galileo, humbled by the Inquisition; Michael Servetus, burned by Calvin in Geneva, for advocating the circulation of the blood; the Nazi attacks against the theories of "Jewish" physicists, Einstein et al., led by two Nobel Laureates, P. Lenard and J. Stark; Lysenko, whose primitive genetics had the support of the state but was none the less false.

Such situations were not always a result of ignorance or prejudice. Garfield (1977) in his very interesting article "Negative Science and 'The Outlook of the Flying Machine' " described the hindrances before the first flight as follows:

> On December 17, 1903, at 10:35 a.m., Orville Wright took off at the controls of "Flyer 1," flew for 12 seconds, and landed safely – the first controlled, man-carrying mechanical-powered flight in history. But almost five years went by before it was generally accepted that

> the Wright brothers had flown in their machine. After all, who were the Wright brothers to make such a claim when the most learned professors, including Professor Simon Newcomb—had "proved" that powered flight was impossible? (p. 8)

The name of Newcomb was well known: he was professor of mathematics and astronomy at Johns Hopkins University, a founder and first president of the American Astronomical Society, and vice-president of the National Academy of Sciences. He also directed the American Nautical Almanac Office. As a scientist, he has still not lost his significance up to now. According to *Science Citation Index*, in the 16-year period from 1961 to 1976, Simon Newcomb was cited 183 times.

Prejudice, armed with logic, is apt to be more harmful to the development of science and philosophy than mere ignorance and superstition. A classic example of the latter was the rejection of the mathematical papers of Evariste Galois by the most eminent mathematicians of France. Group theory was an idea before its time, as was non-Euclidean geometry. Note the refusal of Gauss to publish on this subject for fear of ridicule.

In what way is it possible to explain this stubborn resistance to anything new or unfamiliar, which is catching even for scientists? A general answer to this question is easy. At the early stage of its development, mankind passed through the epoch of magical culture whose one manifestation was unconditional stability guarded by a set of rigid taboos of a sacral nature. [Magical culture preserved in its original form is described by Horton (1975).]

Like Jung (1965), I believe that our unconscious contains everything we have lived through in the process of ethnogenesis, including here the sacral fear of the new. The taboo of magical culture is inherent to the depths of our consciousness just as the urge for revolt is also inherent in some people (see Chapter 2 of this book).

We have only to trace the way in which this old feature from the storehouse of the unconscious manifests itself in our creative life, including scientific activities. As an object of study, I shall take negative reviews and as a model I shall apply the same Bayesian theorem: everything new is filtered by personal perception which stands on guard against it. Now let us turn to our illustration.

The manuscript of my book *Probabilistic Model of Language*[7] (Nalimov, 1974*b*), in which the probabilistic approach to language semantics briefly described above is dealt with in detail, was sent to one philosopher for a review. The manuscript was not strictly philosophical,

[7] Published in English under the title *In the Labyrinths of Language: A Mathematician's Journey* (Nalimov, 1981).

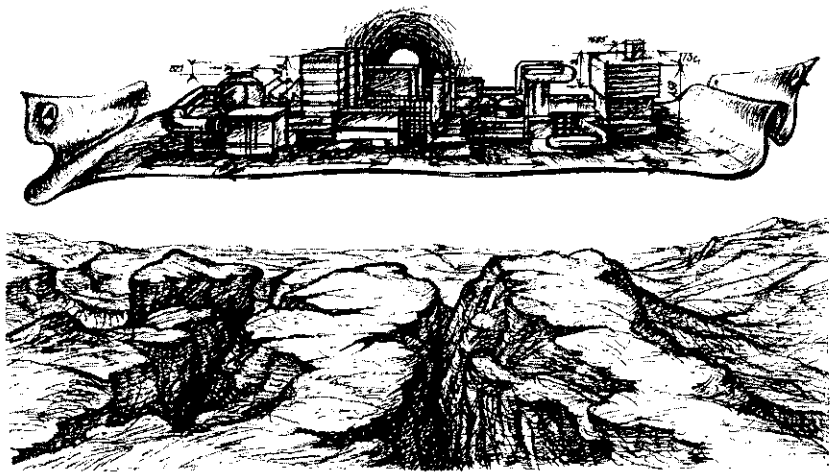
but the editorial staff, to be on the safe side, still decided to check on the presence of philosophical errors and for this purpose chose a philosopher with a special attitude. His review affords us a clear picture of his personal prior distribution function $p(\mu)$ giving those requirements which, in his opinion, a good philosophical paper should meet (here μ is a field of values for evaluating philosophical works). His system of value postulates seems to be so constructed that such a book should be thought suitable if much attention in it is paid to opposing the harmful philosophies of the capitalist West: Machism, religion, or to the manifestations of class struggles in modern times, e.g., the struggle against nationalism. Further, it is possible to imagine a function $p(y|\mu)$ constructed while reading the book in question. The reviewer could not but notice that its principal subject was the probabilistic model of language, its interpretation, the semantic scale of languages, etc. Then he could see that I touched slightly upon the questions usually discussed in criticizing Machism and that I was interested in the languages of religion and, though very briefly, mentioned the specific features of ancient Hebrew books. Finally, it is possible to imagine the way the posterior distribution function $p(\mu|y)$ looks, i.e., the way the scale of estimates will look with respect to evaluating the given concrete problem y. Everything connected with the main content of the book is simply lost here since the prior distribution function is arranged so that to these statements there is ascribed precisely zero value. The posterior distribution function will be such that, from its interpretation, it will follow that in the review much attention must be paid to the way the author considers Machism, religion, and struggle against nationalism. Proceeding from these value concepts, it is not difficult to pass to the second stage: constructing a system of clear logical judgments concerning the merits and demerits of the manuscript. All this results in a review saying that the manuscript is of absolutely no scientific value: "the author had at his disposal materials he could use to fight against Machism, but he has not succeeded in it . . . he resorts too often to religious texts, which is inadmissible for a Soviet scholar . . . the author has not drawn a due conclusion in favor of the Russian language and scientific outlook, which is especially objectionable when all honest-minded people, including working Jews, are fighting against Zionism . . . Indeed, mentioning in passing Hebrew books written only with consonants, the author does not use this to fight against criminal Zionist activities."

All these remarks are directed toward a book which in no way pursues political or propaganda goals, but is purely scientific. Its subtitle is *On Relation of Natural and Artificial Languages.* In the book I developed my ideas concerning language with a quite clear-cut task in mind: I wished to understand in what way scientific language should relate to

everyday language, in what way scientific terminology should be built, what is the role of mathematics as a language used to describe the external world, what is the implication of the fuzzy semantics of everyday words, and in what way people understand each other when using such words in their speech. Without being able to answer such questions, we cannot solve the problem of artificial intelligence, or that of a man–computer dialogue. To be ready to solve engineering problems, we have to make use of all information on human language, including that concerning cultures of the past. But the reviewer turned out to be a philosopher who perceived the text through a very narrow filter. Everything said above had no interest for him. Despite his quite deprecative estimation of the book, it was published by the publishing house Nauka without any essential corrections, and reviews of the book in both Soviet philosophical journals, *Problems of Philosophy (Voprosy Filosofii)* and *Philosophical Sciences (Filosofskie Nauki)*, were favorable. Philosophers and linguists with other initial value concepts had no difficulty understanding the book.

This example has the flavor of an anecdote, but it is taken from life. Moreover, the editor-in-chief took the review quite seriously and ordered that the manuscript not be sent to the printing house. The example is interesting because it shows how it is possible to make a very strange evaluation by means of logically precise methods: everything can be explained by the fact that a narrowly built system of postulates was used to solve a much more broadly formulated problem. I believe that such cases of odd decision taking are widespread.

18. The probabilistic model must not be regarded too straightforwardly. Of course, I do not think that in reality a person constructs the above-mentioned distribution functions and then multiplies and renorms them. This is just an attempt to give a formal description of the complicated socio-psychological process of whose mechanism we are, strictly speaking, ignorant. It is an attempt to a view a complex system in a certain aspect; this is just a metaphor – in reality, a person behaves "as if but not so" as in the model. The meaning of the model lies in that it allows us to imagine how, in the process of constructing value judgments, the postulates are formed on which further logical judgments are based. The crucial role here is played by the previous background of a person, which determines his system of prejudices. But prejudices manifest themselves in a familiar and, consequently, clear way while the problems previously faced are being evaluated. It seems reasonable to believe that, in solving new problems, prejudices are transformed as suggested by the Bayesian model, and in this situation such odd cases may arise (as in the above example) that they are readily perceived as irrational. I believe this is the kind of behavior to be expected in discussing the problems of global



Triumph of the Ecological Problem

ecology, especially when its eschatological character becomes universally acknowledged.

The Role of Science in the Evolving Ecological Crisis[8]

It may be asked what has caused the dominating role of science, scientific activities, and scientific outlook in our society, and the concurrent shift into the background of all other manifestations of human spiritual life.

A simple answer emerges if the development of science is juxtaposed to that of biological species. In biology, separate species, at least at the initial stages of their development, increase numerically according to the law approximately given by an exponential curve. Then, when external resources are running short, the exponential curve turns into a logistic or some other S-shaped curve with satiation. Observations show that a biological system is structured so that it transforms the Earth in a manner favorable for itself, improving its ecological background.

[8] A brief version of this section was published in the collection of papers *Value Aspects of Natural Sciences*, Abstracts of the Reports of the Theoretical Conference of the Central Board of Philosophical Seminars of the USSR Academy of Sciences and Obninsk CPSU Town Committee, Obninsk, 1973, p. 79. An adapted version was published for a wider audience in the journal *Izobretatel' i Ratsionalizator* (No. 7, 1977).

This process can be noted by traveling in the mountains: there we see plants slowly destroying rocks. Something of the kind is taking place in science. Publications, journals, the number of researchers—all of these grow exponentially, provided the resources are sufficient.

Thus, science as a system creates ecologically favorable conditions for itself. Under its impact, technology develops, which provides funds and other means for further development. It liberates people for science and generates an industry for building scientific instruments.

Technological development then influences the social outlook: a new scale of values emerges. The old prestige values—heroism and courage, independence and pride, poetry and dreaminess, sympathy and mercy—sink into the background. Science in its progress transforms the surroundings favorably for itself. It is now approaching satiation, which will destroy it before the biosphere is destroyed.

If the number of people engaged in science and the funds allotted for its development do not grow exponentially and, therefore, the scientific community starts aging without being replaced by new members (the signs of which we can already see), and if new technological means necessary to carry out a permanent intensification of experiments cease to be introduced, then the stagnation of science will be unavoidable.

At the moment we sense that the prestige of science is decreasing. At least the prestige of the exact and engineering sciences is declining, as evidenced by the decreasing numbers of applicants to higher educational institutions of this kind in the USSR. People in science have become aware, more intuitively than consciously, that something is going wrong with science, even that something terrible is happening to it. And science is aquiring humanistic tendencies, which are manifested in two ways. On the one hand, representatives of exact sciences have begun to show an interest in basic human problems—language and thinking, psychology, anthropology. On the other hand, science is more and more directing its attention to the universal human problems: the studies of oncology, psychiatry, global ecology. In a number of countries, science is being asked to tackle the problems of controlling social development and forecasting its course.

Concluding Remarks

Thus we see that human social behavior, despite our ability to think rationally, is still rather irrational: ideas regulating social behavior are spreading like an epidemic. The concept of social goals cannot be rationally grounded. Forecasts on a large time scale, if possible at all, can only be negative; progress seems to be nothing else than a walk on a

multiextremal surface—on the rough ground crossed by ravines. Probably this irrationalism breaking through the rationalism of our thinking is just what makes life interesting and meaningful. Otherwise it would have been possible to foresee and program everything, and we would only have to fullfill it pedantically and patiently.

The uncertain character of social behavior creates a game situation. Scientific criticism, common sense, experience accumulated through the ages, logical analysis of situations, and ethical concepts which seem to be built in genetically may all be merely elements of a cosmic game!

But who is our partner in the game? Is a game with only one player possible? A model of such a game is solitaire. Shuffling the cards, the player himself generates the situation of randomness against which he is playing. The rules of the game are such that extra cards are discarded, but if the game is not won, the discarded cards are returned to the pack, and it is shuffled again. Does not the same thing happen in the history of mankind? At moments of crisis, old, completely forgotten ideas come to the surface, and so the pack of cards is shuffled again.

The ecological crisis is primarily an ideological crisis. It is the crisis of Western culture and its concepts of goal and value. Contemporary culture needs respiritualization. Nobody knows from whence new ideas will appear. We come to understand the new interest in the half-forgotten ideas of past epochs.

The role of strict scientific thinking in solving the problems of global ecology is that of providing an acute critical analysis of these problems and of the spontaneously arising methods for their solution. Critical analysis, if sober and bold, may stimulate human creativity before the crisis becomes irreversibly sinister.

Social development, even when influenced by science, may be regarded only as an adaptational walk on a surface crossed by local ravines since no long-term goal does or can exist. The change in the cultural tendencies is, after all, no more than changing the initial point on a multiextremal surface whence the movement begins, as well as changing the direction of the gradient, since the goal function is changed.

Back to Contents
Next to Chapter 11