ENGLISH TRANSLATION BY
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A. Bogdanov

Essays in Tektology

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THE SYSTEMS INQUIRY SERIES

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Contents

Introduction

The purpose of this introduction is to provide the reader with some pertinent facts about the author of the Essays and his other related works. The introduction also offers an explanation for the long neglect of the Essays by contemporary scholars and indicates their relevance to the field of modern generalizing sciences.

A. Bogdanov (pseudonym of A. A. Malinovskii), a medical doctor by education, was a prominent Russian philosopher, economist, biologist, writer, revolutionary and political figure at the turn of the century. He was born on August 22, 1873 in Sokolka, Province of Grodno, into the family of a teacher. After finishing high school with a gold medal, Bogdanov first studied natural sciences at the University of Moscow and then medicine at the University of Kharkov, from which he graduated in 1899. His pre-tektological works were in the fields of economics [3, 12], natural science [4], sociology [5, 6], and philosophy [7].

In Essays in Tektology: The Universal Organization Science [16], Bogdanov condenses his larger work, the three volume treatise, Tektologia (from the Greek word "tekton," meaning "builder") [9, 11, 14], which he had developed and published between 1912 and 1928, the year of his death. The Essays appeared first in a series of articles in Proletarskaya Kultura, 1919-1921, Nos. 7-20, and in 1921 were published in book form [10].

Tektology can be characterized as a dynamic science of complex wholes. It is concerned with universal structural regularities, general types of systems, the most general laws of their transformation and the basic laws of organization of any elements in nature, practice and cognition.

Tektology is relevant today because it has much in common with such modern generalizing sciences as general systems theory, cybernetics [33], structuralism and catastrophe theory. It outlines, complements and further illuminates these sciences.

In formulating the subject matter of tektology, Bogdanov analyzes the material of the most varied fields and concludes that there exist structural relations and laws which are common to the most heterogeneous phenomena. "My initial point of departure," writes Bogdanov, "consists in the fact that structural relations can be generalized to the same degree of formal purity of schemes as the relations of magnitudes in mathematics, and on this basis organizational problems can be solved by methods which are analogous to the methods of mathematics" [14, Vol. 3, p. 209]. Similar considerations of parallel evolution and isomorphic laws in science later led Ludwig von Bertalanffy to "...postulate a new scientific discipline..." which he called the *General Systems Theory* [2, p. 139].

The basic focus of tektology is on the acceptance of a necessity to approach the study of any phenomenon from the point of view of its organization. This necessity stems from the fact that all activities of man and nature are primarily concerned with organization and disorganization of some elements on hand. The organizing and disorganizing processes of man and nature create all sorts of forms and complexes of varied levels of organization. The universe is calibrated on all its levels. In order to understand and conquer this universe, it is necessary, according to Bogdanov, to adopt the organizational point of view; that is, to study any phenomenon and "..any system both from the point of view of relationships among all of its parts and the relationship between it as a whole and its environment, i.e., all external systems" [10, pp. 300-301]. This point of view is identical to the modern systems approach.

Similarly to modern generalizing sciences, tektology arose not accidentally but as a natural reaction of generalizing thought against the growing splintering of science. Its main objective is to systematize the fragmented knowledge of organizational methods so that they can be studied and developed systematically. Bogdanov elaborates on this as follows:

> Tektology must clarify the modes of organization that are perceived to exist in nature and human activity; then it must generalize and systematize these modes; further, it must explain them, that is, propose abstract schemes of their tendencies and laws; finally, based on these schemes, determine the direction of organizational methods and their role in the universal process. This general plan is similar to the plan of any natural science; but the objective of tektology is basically different. Tektology deals with organizational experiences not of this or that specialized field, but of all these fields together. In other words, tektology embraces the subject matter of all the other sciences and of all human experience giving rise to these sciences, but only from the aspect of method; that is, it is interested only in the modes of organization of this subject matter [11, p. 82].

Bogdanov insists that the question of organization should be considered on a universal scale, for in absence of such an integral approach its solution is "...impossible, because a part torn out from the whole cannot be made the whole, nor can it be understood apart from the whole" [11, p. 65].

Tektology is firmly rooted in the natural and social sciences. Bogdanov takes great care to ensure that his new science is not only theoretically sound but also practically useful. The Essays contain numerous illustrations from the most heterogeneous fields in order to show clearly "...the practical applicability of the science— its workable usefulness, its necessity" [16, Preface to the First Edition of Volume I]. Bogdanov extends the application of the methods of tektology in his other works to problems in economics [12], psychology [8], gerontology and hematology [13], national planning [10, pp. 299-326], mathematics [10, pp. 315-326], and many others, including linguistics and biology [11, pp. 278-306; 412-431].

It would seem that tektology should have been enthusiastically embraced by Bogdanov's contemporaries and, particularly, by the proponents of the Soviet scientifically planned society whose needs it was especially developed to serve. But this had failed to occur during his lifetime. Tektology was attacked from materialistic positions by such Marxist philosophers as Weinstein [37], Karev [22], Nevsky [29]. Gonikman [20], and from an idealistic position by Plenge [32], who reviewed the German translation of the first two volumes of Tektology [15]. Most of the criticisms, in fact, were negative.

The novelty of the subject, the rejection by Lenin [26] of Bogdanov's empirio-monistic philosophy, and the subsequent failure of the critics to distinguish clearly between Bogdanov the philosopher and Bogdanov the scientist, the creator of tektology, appear to be the chief reasons why tektological ideas failed to spread in Bogdanov's time. Only a handful of scientists understood the nature and problems of tektology. In the words of Takhtajan:

> Foreign in its universality to the scientific thinking of the time, the idea of the general theory of organization was fully understood by only a handful of men and, therefore, did not spread. Partially, this was due to the fact that Bogdanov had addressed earlier the questions of philosophy, and tektology was, therefore, perceived by many, by philosophers in particular, as a new philosophical system, despite the fact that the author of Tektology considered it to be a "universal natural science," and repeatedly protested against confusion of the universal organizational science with philosophy [35, p. 7].

The Marxist philosophers, in particular, strongly opposed tektological ideas because they feared that in tektology lurked an attempt by Bogdanov to replace the philosophy of Marx. There was some justification for their fears.

His historical review of materialism led Bogdanov to the conclusion that the existence of social classes was not due to the distribution of ownership rights, but arose because of the possession of different levels of organizational experience by individuals in a given society. Thus, the ruling class in a social system is composed of organizers of production, and not, as Marx believed, the owners of the means of production. The elimination of class distinctions cannot, therefore, be achieved through violent revolutions as advocated by Marx and Lenin, but rather through education of members of society in organizational skills; that is, through mass education and proletarian culture [7]. "Like Hegel (and unlike Lenin), Bogdanov saw synthesis and harmony as more permanent and productive than opposition and conflict" [23, p. 331].

Despite the official condemnation of tektology by the Marxist ideologists, it continued to exert a powerful influence on a number of Russian scientists and intellectuals, including such luminaries as A. K. Timiriaziev, I. I. Skvortsov-Stepanov and Nikolai Bukharin. Historical Materialism: A System of Sociology by Bukharin [19] is rooted in Bogdanov's theory of dynamic equilibrium. This theory is very close to Bertalanffy's [2] theory of open systems, which he began to advance in the early 1930's.

Under Stalin, the study of tektology was generally discouraged. Furthermore, the intellectual climate between the two World Wars was also unfavourable to the spread of tektological ideas. Thus, with the passage ot time, tektology was almost completely forgotten.

So long as tektology remained a unique science, it was difficult to recognize its significance. With the appearance of the work of N. Wiener [38] and W. Ross Ashby [1] on cybernetics and the General System Theory of L. von Bertalanffy [2], however, it became quite clear that tektology *was not in vain.* "The point is," writes Setrov, "that between these works there exists an unquestionable succession. It is especially interesting and important that many generally-theoretic problems of the systemic approach are elaborated more fully and rigorously by A. Bogdanov than in the case of the contemporary theory of systems and in cybernetics" [34, p. 59]. Similar conclusions were reached by other Soviet researchers [17, 18, 27, 35]. The original negative evaluation of tektology was subjected, therefore, to a radical review by the Soviet scientists. Currently, tektology is regarded by them as the first fundamental variant of general systems theory and a precursor of cybernetics.

One of the first to evaluate tektology positively and to appreciate its significance to contemporary science was the Polish scientist Tadeusz Kotarbinski [24], whose Praxiology [25] has much in common with tektology. Kotarbinski considers Tektology as one of the few creative works in the field of generalizing sciences which still remains unutilized by contemporary science. Later, tektology received various degrees of recognition from an increasing number of prominent Soviet scientists and philosophers of science including Malinovskii [27], Setrov [33, 34], Bogolepov [18], Blauberg, *et al.* [17], Takhtajan [35], Petrushenko [30], and many others.

Contemporary Soviet scientists, however, "...are by no means inclined towards idealization of tektology" [17, p. 27]. They continue to emphasize what they call the old philosophical and political "errors" of Bogdanov and cannot forget his Machist past. Tektology is, therefore, criticized for its elements of relativism, mechanism and positivism which characterize Bogdanov's view of the world, and which, in their opinion, prevent Bogdanov from developing convincing answers to a number of questions, including the fundamental question of tektology: Why is a system as a whole greater than the sum of its parts?

In fairness to Bogdanov, however, it is important to note that he had never claimed that tektology represented a completed theory which would provide *final* answers to those questions. On the contrary, he conceived it as an evolving science. "What I will not do," Bogdanov wrote prophetically, "will be done by others. Science is not an individual but a collective matter and its realm is infinite" [11, p. 12].

Bogdanov regards any "truth" as relative and valid only within the limits of a particular epoch [7]. He recognizes that with the addition of new facts, the hypotheses of tektology may be altered or even rejected. But even then, their usefulness will continue in gathering organizational experience and in the development of organizational methods, inasmuch as they "...facilitate the learning process of solving organizational problems in general" [16, p. 166]. "And in the history of science," writes Bogdanov, "there can be found a number of theories and hypotheses which became obsolete long ago, but which, nevertheless, can still serve as a valuable tektological material. In this sense, tektology will preserve for mankind much of its labour, crystallized in the verities of the past. Undoubtedly, contemporary verities will also become obsolete and die in their time; but tektology guarantees that even then they will not be simply discarded, will not be converted in the eyes of future generations into naked, fruitless illusions" [16, p. 166].

Tektology also has common elements with modern structuralism, especially that of Jean Piaget [31]. The concepts of wholeness, transformation and self-regulation are common to both. They receive, however, much more comprehensive and deeper treatment in tektology. Bogdanov also fully agrees with Piaget's proposition that "...the construction of a demonstratively consistent relatively rich theory requires not simply an 'analysis' of its 'presuppositions,' but the construction of the next 'higher' theory!" [31, p. 34]. Tektology is an expression of this point of view in the field of organization.

Chapter VIII of the *Essays* presents a theory of change or crises. Conceptually, it is very close to Rene Thom's [36] catastrophe theory, which is a mathematical method for modelling gradually changing processes producing sudden changes or catastrophes in forms. Just like Bogdanov, Thom perceives the universe as "...a ceaseless creation, evolution and destruction of forms and that the purpose of science is to foresee this change of form and, if possible, explain it" [36, p. 1]. Both draw their inspiration about change from the first pre-Socratic philosophers, Anaximander and Heraclitus.

There are, of course, a number significant differences between tektology and contemporary generalizing sciences. Differences in focus, information used in developing each of them, and the times when each emerged, generally account for the differences in terminology, formulation of the subject matter, and interpretation. Bogdanov has not, for example, the contemporary theory of automata, but devotes considerable attention to problems of automation and self-regulating mechanisms [12, 16].

On the important question of aging, Bogdanov shares the views of modern researchers who consider aging as a destruction of the organism, its loss of organization. But as far as the correlation of *variety* and the *level* of *organization* is concerned, Bogdanov differs fundamentally from most contemporary researchers [33]. According to him, the positive correlation of the two exists up to a certain limit. Differentiation, that is, growth in tektological variety, if not balanced by integration, leads to an accumulation of contradictions within a system and eventually to its complete collapse. This is exactly what happens with aging. According to Bogdanov, aging is a contradiction between form and content, between the variety of an organism and its inability to organize this variety [13, 16, pp. 145-157].

Generally, by focusing on *organization* on a universal scale, Bogdanov succeeds in outlining or even creating a kind of metascience for modern generalizing sciences. By being enriched by the organizational experience which has been gained since its creation, tektology can continue to serve as a cornerstone for the further development of the general science of organization.

In the English speaking world, tektology was rediscovered quite recently. The first comprehensive outline of its principal ideas appeared in the relevant literature as late as 1975 [21]. Professor Mattessich [28] is one of the first Western scholars to evaluate it positively. A comprehensive analysis of tektology is yet to be made. The present translation of Bogdanov's Essays, including the prefaces to the 1912 and 1922 editions of Tektology, is, therefore, offered to the reader in the hope that it may, at least in an histocial sense, bring the ideas of tektology into a proper perspective and encourage their further study.

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Preface

to the

First Edition of Tektology, Volume I

The laying of the foundations of science, unifying the organizational experience of mankind, the vitally-necessary science, is a matter of enormous importance. In taking the initiative, I was fully conscious of the seriousness and the responsibility of this step. Yes, and the responsibility: failure in the attempt, an erroneous statement of the basic questions, incorrectness in initial solutions could have compromized for a long time the task itself, deflected from it for many years the interest and attention of those who must work on it. Still I ventured because it is necessary to begin sometime. It is possible that others could have fulfilled the task better; but one must wait for these others. . .

The first part of the work which is being offered now represents an investigation of the two universal organizational principles: the formulating principle of ingression and the regulating principle of universal selection.

The conditions of place and time have allowed me to investigate this only in the most general form. However, I think that even this will be sufficient in order to introduce the reader, especially the reader who is studying the subject, to the basic meaning and spirit of the methods of the new sicence.

I made special efforts to show clearly, in concrete and vital illustrations, the practical applicability of the science — its workable usefulness, its necessity. In this lies its fortunate pecularity: from the very beginning, tektology is able to leave the abstractly-cognitive realm and occupy an active role in life.

I also attempted to explain distinctly that tektology is not something principally new; it is not a leap in scientific evolution, but a necessary conclusion from the past, the necessary continuation of what has been done and is being done by men in their practice and theory. This is in part a justification for my boldness. . . if any justification is necessary.

I am deeply convinced that in further work I will no longer be alone.

28(15), December 1912

A. Bogdanov

Preface to the New Edition of Tektology

The years which have elapsed since the time of the first edition have brought in considerable new material; in the work, some new conclusions have emerged and it has become possible to add greater precision to the old conclusions, although, in essence, it has not so far been necessary to repudiate anything of importance. The least satisfactory appeared to me to be the order of exposition itself, which originally proceeded on lines, so to speak, of the least resistance, beginning with that which was best prepared by the preceding evolution of science and passing on to the less known conceptions, and not on the lines of the most logical sequence. It was necessary to revise the work. The revision was outlined and partly executed in a series of journal articles, "Essays in Organizational Science" (Proletarskaia Kultura, 1919-1921, Nos. 7-20). But because of editorial constraints it was necessary to abridge the material considerably. In the present edition, the architecture of the "Essays" was taken as a basis, and as much of the previous material and some new material as possible is included,— unfortunately, not all the material by far that has accumulated: the limitations of time and energy did not permit this, but to postpone the revision would not have been possible, since the first edition became a bibliographic rarity, and even the journal with the "Essays" was difficult to obtain.

With a new arrangement of the material it was not possible to preserve the former divisions of Volumes I and II; therefore, they are issued in one book and the newly written Volume III is added to them.

The main change in the architecture of the work is that the formulating mechanism is placed ahead of the regulating, as it logically should be; moreover, there is first given a general outline of both mechanisms and then their more detailed investigation.

There is a slight change in terminology. The expression *conjunctive sum*, inadequately reflecting the idea of composition of activities which are mentally distinguished by analysis from the whole complex, is replaced by a more precise expression ***analytical sum.*** The term *copulation* is removed, since it is not fully essential, etc.

The third, new volume of the work embraces the teaching about crises and organizational dialectic. This concludes the exposition of the general organizational theory, so far as it has become clear to me. Next must follow special works on the application of this theory to separate fields of science, which are destined to be deeply transformed by it. Two such works, one of which deals with social sciences and the other with psychology, have already been to a great extent prepared by me. The first of these is even partly published. The point is that I have systematically applied the methods of tektology, not denoting them by this name, in a series of works on economic science and on the evolution of ideologies; such, in particular, are the three textbooks on political economy— The First Course, The Short Course, and the unabridged Course, which were written in collaboration with I. Stepanov, and in which the theoretical and methodological parts belong to me; and also The Science About Social Consciousness. In a public academic lecture, I outlined the application of the same point of view to the teaching about the development of social technology, etc. Here, by and large, I will have to bring together into one whole the ready elements. But all of this should, according to my plan, enter a new cycle of works for which the present work will serve as a general basis, and which I hope to accomplish not only with my own efforts.

If nine years ago my attempt turned out to be ideologically premature, today the whole matter is quite different. The experience of the past years, the years of great disorganization as well as of great organizational attempts, have engendered in the entire world a sharp need for the scientific statement of organizational questions. Partial applied sciences of this type are being developed— about the organization of a workshop, the organization of an enterprise, an institution generally, an army. . .

Those concerned are increasingly beginning to feel the inadequacy and shaky empiricism of these attempts, the necessity to broaden the task, – although they fail to approach its world scale and universal regularities. In Germany, 2-3 years ago, one professor (Plenge from Münster) arrived, apparently quite independently, and on different grounds, even at the formulation of the idea of "Allgemeine Organisationslehre," which coincides with the title of this book; but he understood by this only the science of human organizations, and besides, only within the framework of their planned functioning;

beyond the general approach to this question, in a pamphlet containing three lectures which were read at the Münster University, he has not gone so far.

Fortunately, it will apparently not be necessary to await for the time when the Europeans will independently repeat what is already done. At least, in Russia— I can state with great joy that my hope for the comrade-collaborators joining me is finally justified. A number of young, and even not so young, scientists have definitely adopted the path of tektological investigation, applying its methods and the most firmly established conclusions to various vital questions of practice and science: concerning state-economic plan, programs and methods of pedagogy, analysis of transitional economic forms, socio-psychological types, etc. In the literature, so far the results are not great in quantity; but the work goes on— vital, stubborn, convincing work.

Welcoming comrades to common endeavour, I dedicate this book to them.

Moscow
19, November, 1921 A. Bogdanov

I

What Is Organizational Science?

1. The Unity of the Organizational Point of View

i. The Organizational Activity of Mankind

In the struggle of mankind with the elements, its aim is *dominion over nature.* Dominion is a relationship of the organizer to the organized. Step by step, mankind acquires control over and conquers nature; this means that step by step it *organizes the universe*; it organizes the universe for itself and in its own interests. Such is the meaning and content of the age-long labour of mankind.

Nature resists elementally and blindly with the terrible strength of its dark, chaotic, but innumerable and infinite army of elements. In order to conquer it, mankind must organize itself into a mighty army. Unconsciously, it has been doing this for centuries by forming *working collectives*, ranging from the small primitive communes of the primordial epoch to the contemporary cooperation of hundreds of millions of people.

If mankind had to organize the universe only with the forces and means given to it by nature, it would not have any advantage over the other living creatures which also fight for survival against the rest of nature. In its labour mankind uses *tools,* which it takes from the same external nature. This forms the basis of its victories; it is this which long ago provided and continues to provide mankind with a growing superiority over the strongest and most terrible giants of elemental life and which distinguishes it from the rest of nature's kingdom.

An even more difficult problem for mankind is to individually and collectively organize itself and its own efforts and activities. In the complexity of the human organism and society blind and conflicting elemental forces are hidden, at times as terrible and destructive as the forces of nature, the dark mother of mankind. Fate has made us witnesses of the most destructive and monstrous explosion of these forces; human history speaks clearly about them: the chain of centuries, covered with fire and blood, full of the horrors of starvation, exhausting labour and the helplessness of millions side by side with the parasitic luxury and cruel rule of the few. The self-organization of mankind is a struggle with its own internal biological and social primordial forces; for this mankind needs tools just as much as for its struggle with external nature, although different tools, namely the *instruments of organization.* Mankind formed these tools with great difficulty and sacrifice.

The first such instrument is the *word.* Every conscious collaboration of people is organized by means of words: a call to labour in the form of a request or an order uniting the workers, division among them of tasks, indication of the sequence and relationship of their acts, encouragement to work which concentrates their efforts, warning about the lack of agreement, work stoppage, regrouping, change of direction of efforts—all these things are carried out by means of words. Gigantic collectives are created by the force of a word; gigantic collectives are governed by it. People of XXth century have seen how the command of the most insignificant individual has directed millions of people into an unprecedented hell of iron and dynamite, of murder and destruction. It was not for nothing that ancient thought, profound in its naivety, begat the myth about the creation of the world by the word, and believed in the infinite power of the word over the elements: water and mountains, storms and tempests, disease and death had to obey the person who knew and uttered an appropriate word. The organizing force of the word was made into a fetish and generalized over the entire universe, and this did not slip away from the primitive consciousness as much as it does from the contemporary mind.

The second Instrument of organization, finer and more *complex* is the *idea*. The idea always appears as an organizational scheme, whether it comes out in the form of a technical rule, scientific knowledge or artistic conception, whether it is expressed in terms of words, by other signs, or through art images. A technical idea coordinates the efforts of people in a direct and manifest fashion; a scientific idea, as an instrument of a higher order, does the same thing but more indirectly and on a larger scale, of which a striking illustration is the scientific technology of our own epoch; an artistic idea serves as a living means of rallying the collective toward a unity of perception, feeling and mood; it rears an individual for his life in society, prepares the organizational elements of the collective and introduces them into its internal order. Ancient thought vaguely realized the organizational role of ideas, seeing in them the guiding instructions from above; the latest thought, however, has in most instances lost even this consciousness.

The third instrument is *social norms*. All of them–custom, law, morals and decorum–establish and regulate the relations among people in a collective and thus strengthen their connections. Social norms were understood by the concrete consciousness of patriarchal times as the behests of ancestors or commands of gods, the revered forefathers who organized the collective life; and the latest abstract thought, not able to penetrate into the socio-organizational nature of these norms, looked for their basis in the emotional experiences of separate individuals.

Where does mankind obtain such instruments as speech, ideas and norms? Not from external nature, as in the case of material instruments, but from its own; from its own activities and feelings, from its own *experience*. All of them are *products of organized experience*, realized by mankind in the course of thousands of years. The *word* is not an empty sound, but a social crystal of notions and aspirations transmitted from man to man; and such are also other more complex forms of ideology.

The entire content of human life has unfolded before us and is now possible to sum up. The old teacher of scientific socialism, Engels, expressed it by a formula: production of people, production of things, and production of ideas. The concept of organizing action is hidden in the term "production." We shall, therefore, make this formula more precise: *organization of the external forces of nature, organization of human forces, and organization of experience.*

What have we discovered? Mankind has no other activity except organizational activity, there being no other problems except organizational problems.

But do we not also see everywhere destructive activities and disorganizing problems? Yes, but this is a particular instance of the same tendency. If society, classes and groups collide destructively, disorganizing each other, they do so precisely because each collective aims at an organization of the world and of mankind for itself, according to its own ideals. This is the result of the separateness and isolation of organizational forces; the result of a lack of their unity and common, harmonious organization. ***This is the struggle of organizational forms.***

Thus the conclusion is supported that all the interests of mankind are organizational. But it follows from this that there cannot be and should not be any other point of view on life and the universe other than the organizational point of view. And if this is not as yet realized, it is only because the thinking of people has not yet completely broken out from the membranes of fetishism which obstruct the path of its evolution.

ii. The Organizational Activity of Nature

Well, let it be so: we are organizers of nature, of ourselves and of our experience; we shall then consider our practice, cognition and artistic creations from the organizational point of view. But is elemental nature an organizer? Will it not be a naive subjectivism or poetic fantasy to apply to her events and actions the same point of view?

Yes, certainly nature is the *first* great organizer and man himself is only one of her organized products. The simplest of living cells, which can be seen only with thousand-fold magnification, surpasses in the complexity and perfection of its organization all that man can organize. Man is still a student of nature and a rather poor one at that.

But if the phenomena of life can be investigated and understood as organizational processes, are not there in addition broad regions of the "inorganic" universe, or dead nature, which are not organized? Yes, life is but a tiny part of the universe, lost in the ocean of infinity; this does not mean, however, that the lifeless and the "inorganic" are unorganized. Until recently, this old error reigned over the thought of mankind just because of man's organizational weakness. It is now coming to an end.

Today, science destroys previously impassable boundaries between living and dead nature, filling the gulf between them. In the world of crystals were discovered some of the typical properties of organized bodies, which had been considered before as exclusive characterizations of life. For instance, in a saturated solution the crystal changes its form by an "exchange of matter;" it also restores damages to its form, as if "healing its own wounds;" and under certain conditions of saturation it "multiplies," etc. And the connections between the realm of crystals and the remainder of inorganic nature are such that it cannot be maintained that there are some fundamental and unconditional differences between them. Among liquids there are formations called "fluid crystals" which possess most of the crystalline properties. And the "life-like crystals" of Leman, obtained under known temperatures from ethylene ether, are capable not only of multiplication by division and "copulation," that is amalgamation in pairs, but also of feeding and growth by assimilation of matter, and of moving like an amoeba: all the crucial properties which are usually held to determine the lower unicellular organisms.

Also, in the atmosphere saturated with steam, an ordinary drop of water on a blade of grass grows and multiplies through division. And its surface layer, physically analogous to an elastic film, "protects" its form similarly to the thin, elastic membranes of many living cells, such as bacteria.

It would be strange to consider as "unorganized" the harmonious, titanically stable solar systems and their planets which were formed over myriads of ages. In contemporary theory, the structure of each atom, in its type, with its amazing stability based on the immeasurably fast, cyclically-closed movements of its elements, is the same as that of the solar system.

Complete disorganization is a concept without meaning. It is , in reality, the same as naked non-being. For a complete disorganization it is necessary to assume a complete absence of connections; but that which has no connections cannot present any resistance to our efforts, and only in resistances do we learn about the existence of things; consequently, for us there is no such thing as complete disorganization. And to think about absolute disconnectedness is possible only verbally: it is not possible to put into such words any real, living representation, because an absolutely incoherent representation is not representation at all— generally it is nothing.

Even the imaginary emptiness of interplanetary space— the interplanetary ether— is not deprived of lower, elementary organization. This organization possesses resistance; motion can penetrate it only with a limited velocity; and when the velocity of a moving body increases, then, in accordance with the ideas of contemporary mechanics, this resistance also grows, at first with an imperceptible sluggishness, then faster; and in the limit, equal to the speed of light, it becomes quite indeterminate and infinitely large.

Thus, the experience and ideas of contemporary science lead us to the only integral, the only monistic understanding of the universe. It appears before us as an infinitely unfolding fabric of all types of forms and levels of organization, from the unknown elements of ether to human collectives and star systems. All these forms, in their interlacement and mutual struggle, in their constant changes, create the universal organizational process, infinitely split in its parts, but continuous and unbroken in its whole.

2. The Unity of Organizational Methods

Such is the organizational point of view. It is perfectly simple and immutable in its simplicity. What does it give us, what paths does it open before us?

Practice and theory would benefit little if the entire matter came to the philosophical position that "everything is organization." ***Methods*** are necessary and important for practice and theory. In this regard, the inference is clear: "all methods are in essence ***organizational***." The problem, therefore, is to understand and study every method as organizational. This may be a great step forward, but only on one condition: organizational methods must be amenable to scientific generalizations.

If organizational methods were different in different fields, if, for example, the organization of things, that is technology, had little in common with the methods or organization of people, that is economics or the organization of experience, that is, the universe of ideas, then mastery over them would not be facilitated by a mere labelling of all of them as organizational. It is quite a different story, if after investigation it turns out that it is possible to establish between them a connection, kinship, and place them under common laws. Then the study of that connection and those laws would permit man to gain mastery over those methods and to develop them in a planned fashion; such a study would become one of the most powerful instruments of any practice or theory. What is in fact true, the first or the second?

The deepest distinction which is known to exist is that between the spontaneously blind action of nature and the consciously planned efforts of people. It is here that we should expect the greatest heterogeneity of methods and the greatest lack of unity. It is best, therefore, to begin our investigation at this point.

First of all, our investigation runs against the fact of man's *imitation* of nature in his modes of organizational activity.

Nature organizes the resistance of many living organisms against the action of cold by covering them with fluffy furs, feathers or other membranes which transmit little heat. Man achieves the same results in a similar way by making warm clothing. Elemental evolution has made it possible for fish to move in the water; for this purpose the fish has developed a definite form and body structure. Man gives a similar form to his boats and ships and, moreover, reproduces in them the structure of the fish skeleton: the keel and frame correspond precisely to the spine and ribs. The seeds of many plants and animals with flying membranes, etc., move from place to place by means of "sails;" man has mastered the method of sailing and used it widely throughout his history. The natural instruments of animals, such as the fangs and claws of predators, most likely served as models for the knives and spears of primitive savages, etc. Many such examples can be found in the history of man.

The very possibility of imitation is, in essence, a sufficient proof that between the elemental organizational work of nature and the consciously planned work of men there is not, in priniciple, any impassable difference. There cannot be imitation where nothing is in common.[1] But this basic similarity stands out even more visibly and convincingly where man, while not imitating nature, develops organizational devices which he later discovers to exist in nature.

The entire history of the evolution of anatomy and physiology is full of discoveries of mechanisms in the living organism, from the very simple to the most complex, which were previously invented independently by people. For instance, the skeleton of man's motor apparatus represents a system of varied levers which has two blocks (one for the neck and one for the eye muscle) ; but levers were used by people for the movement of weights thousands of years before this phenomenon was explained by anatomists, and blocks were used for many hundreds of years. Sucking and force pumps containing valves were built long be-

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1 "This is a sufficient proof of the essential homogeneity of the organizational functions of man and nature: an idiot cannot imitate the creativity of a genius, a fish the eloquence of an orator, a lobster the flight of a swan; imitation is everywhere constrained within the bounds of homogeneity. (Tektology, Vol. 1, p.23)

fore the discovery of a similar apparatus in the heart. Also, musical instruments containing resonators and sound membranes were invented long before the structure and functions of the vocal organs in animals were understood. Similarly, it is most likely that the first gathering lenses were made in an unconscious imitation of the crystalline lenses of the eye. And the organization of electrical organs in a fish was investigated after the physicists constructed condensing batteries in accordance with the same principle.

These are the most obvious examples from one restricted field; many more can be cited. But here is another comparison: the social economy of man and that of higher insects. Imitation between them is out of the question. Nevertheless, there is a striking parallelism in the manner of production and in the forms of collaboration used by them. The construction of complex, subdivided dwellings in the case of termites and ants, and the "cattle-breeding" of many ants which keep grass aphides as a kind of milch cattle, are generally known facts. There are also found the beginnings of agriculture in some American types: the weeding of grasses around suitable food cereals. Most likely, a similar beginning in agriculture was made by man. Also, the cultivation of edible mushrooms inside the anthill by the leaf-eating ants in Brazil is quite well established. The wide collaboration and complex division of labour among social insects are again well known. True, the division of labour is primarily "physiological;" that is, it is directly related to the special structure of the organism in various groups, such as workers, soldiers, etc.; but it is necessary to note that among men the original division of labour was precisely physiological and that it was based on the distinction between male, female, adult, infant, and aged organism. The organization of ants is basically patriarchal in nature; moreover, the queen ant is not the leader at work and has no power in her community, but is its living cosanguineous bond. There is reason to suppose that in primitive forms of matriarchy among people the first mother performed a similar role. Besides, among many ants there is an embryonic authoritarian division of labour in the form of "slavery;" according to some authorities, termites have leaders among the castes of warriors— "officers" and subordinated "soldiers." Finally, there is reason to believe that ants have some methods of communication, permitting them to transmit quite complex information which indicates the "articulate" nature of these methods; but it is not known whether the "speech" is in terms of sound or tactile signals in which differences in the contact of feelers serve as signals; the latter appears to be the more probable.

Such is the organizationally-cultural parallelism which arose under the ***completely independent*** evolution of both sides: and it can be maintained without a doubt that the common ancestors of people and insects were not at all social animals.

And so, the path of the elementally-organized creations of nature and the consciously organized work of man can and must be subjected to scientific generalizations. However, the old thought drew its own "impassable" boundaries not only in this case, but also established a number of other differences— "absolute" differences in essence. One of such differences— that between "living" and "dead" nature— we have already considered, and it turned out that from the organizational point of view it is not at all impassable, that it represents a difference in the degree of organization only. And we saw quite parallel organizational combinations on each side of this border— processes of the "exchange of matter," "propagation," and the "restoration of disturbed forms" in the inorganic world, etc. It is now possible to cite other striking illustrations of this basic homogeneity. Solar planetary systems on one level of the ladder of inorganic forms, and the construction of the atom as rep-represented by contemporary science on the other, represent a characteristically centralist type: one "central" complex— the sun or the positive electrical nucleus of the atom— appears as chiefly determining the motion and relationships of other parts and the whole. In the realm of life, the centralist type is one of the most common: it is sufficient to recall the role of the brain in animal organisms, rulers in autocratic social organizations, and the queen among bees and ants, etc. The second very widespread type represents a combination of a firm or elastic membrane with a more mobile liquid or less stable content. This appears to be a form of equilibrium of most planets in the universe or in the simple drop of water in which the membrane creates a surface layer with its own properties; but the same form of construction is common in the vegetable world, and is not infrequent in living cells and a multitude of organisms clothed in an external skeleton.

On a wider scale, periodic oscillations or "waves" are the most widespread method in nature of preserving or restoring equilibria. This is a kind of general model for innumerable processes of the inorganic universe, from the ones directly observed to those received by science on the strength of theoretical necessity: waves in the air; heat vibrations in hard bodies; electrical, light, and "invisible" rays ranging from hertzian waves to x-rays; and at the other end of the universe, the "rotation" of the heavenly bodies, can all be conceived as complex periodic oscillations. . . . .
But this model is also applicable without limit to the realm of life; almost all of the life processes are of the periodic oscillating type. Such are the pulse and breathing, work and rest, and the vigilance and sleep of organisms. The replacement of generations represents a series of waves superimposed one upon the other; it is the real "pulse of life" in centuries, etc.

Most philosophers and many psychologists subscribe to the other impassable boundry between the "physical" and "psychical." Here again it is possible to maintain the existence of a complete disparity of organizational methods. However, the same philosophers and psychologists recognize, to different degrees and under different labels, the parallelism of psychic phenomena with the physical nervous processes. But parallelism means precisely that the relationship of elements and combinations on the one side corresponds to the relationships on the other; that is, it denotes the basic unity of modes of organization. How is it possible for a "psychic image" to correspond to the "physical object," if the parts of the one were not joined similarly to the parts of the other? And, for example, the same oscillating rhythm of work and rest, which is peculiar to physical processes in the organism, is discovered to be quite parallel in the psychical processes; and it is often observed in the psychic processes even when it is not yet possible to ascertain visually the physiological changes; even if, let us assume, in the form of "waves of attention." And any product of "spiritual"creativity— a scientific theory, a poetic work, a system of legal or moral norms–has its own "*architecture*," and represents a subdivided totality of parts, performing a variety of functions complementing each other: the principle of organization is the same in each physiological organism.

Thus, everywhere we see a unity of organizational methods: in psychical and physical complexes, in living and dead nature, in the work of elemental forces and in the conscious activity of people. So far this unity has not been precisely established, investigated and studied: there has not yet been a *general organizational science.* Now its time has come.

3. The Path to the Organizational Science

i. The Organizational Point of View in Primitive and Religious Thought

Although this science does not as yet exist, its basic point of view was conceived during the first steps of mankind, together with the beginning of speech and thought.

The first word-concepts were designations of human labour actions; these designations were completely natural, because they were shouts of exertion and labour interjections. When reproduced in the absence of such exertions, they expressed an aspirition, a call to it or its living representation. Consequently, they were aroused by everything which was a sufficiently vivid reminder of it. Here is, for example, the primary root "rag," which in Aryan languages means "razbivat' " (to break); from it originate our words "vrag" (enemy), "razit' "(strike), "raz" (once) and the particle "raz" in verbs. "Rag" probably represented simply a growl during the striking of a blow; this word could appear on the scene not only while one was striking a blow or expressing a call to it, but under the most varied conditions having a connection with such a call: at the sight of an enemy or a thought about him, at the sight of arms which were used for striking the blow, or at a result of the blow; that is, at the sight of something broken or fractured, etc. All of this was designated or, more correctly, marked by the same sound; thanks to the original vagueness about the meaning of root words, each of them could become a point of departure for the development in the future of thousands of other words with increasingly ramified yet also increasingly more definite meanings.

From the very same vagueness arose the basic condition of man's thought about nature: the basic metaphor. A metaphor, which literally means a "transfer," is, generally, the use of a word denoting one phenomenon to denote another phenomenon having something in common with the first; for example, when a poet calls the dawn "bloody," the spring "sweet" or the sea "ferocious,"he is speaking metaphoricallly. The distant ancestor of the Aryan people did not know the meaning of the metaphor, but naturally used the same root "rag" when he observed or imagined some shattering action of elemental forces,such as a falling rock breaking and crushing everything in its fall or a storm breaking trees, etc. Elemental action was denoted by the same word as human action. This is the basic metaphor. Without it, people would not be able to talk about external nature and, consequently, develop concepts about it: thinking about the universe would not have been possible.

With the basic metaphor mankind crossed the deepest gulf of its experience; it crossed the boundary between itself and its age-long enemy, the elements. The basic metaphor is the first embryo and prototype of the unity of the organizational point of view on the universe. The word served as an instrument of organization for socio-human activities; among other instruments, it was used for the unification of human experience in relation to the activities of the external world; these and other activities were principally generalized in the organizational sense. Primitive thought did not constitute a system or a "worldview;" word-concepts were related too closely to direct actions and were not thought of in their own separate connections and grouped specifically into one whole. A specific organization of words began to appear at a higher level of evolution, exactly at the time when in life itself thought began to separate from the physical-labouring efforts, when there appeared a division of people into leaders and executors, organizers and the organized. Where one person considers, decides and orders, and the other executes, there appear as if two poles: the pole of thought and the word on the one hand, and the pole of muscular work on the other. The leader, such as a patriarch or a war chief, had to put together in his head a plan of an often very complex and extensive nature, consisting of a great number of actions to be executed by other people subordinated to him; in this plan thought images or notions naturally united among themselves, not with the actions which were later to be realized separately, although they were dependent upon such actions. In this way an independent organization of thought was conceived, thought as a system; what is imprecisely called a worldview or, more correctly, an understanding of the world.

With this, the initial unity of the organizational point of view is not only preserved, but also strengthened. The organization of thought, of course, was determined by the organization of labour, whose ends it served. And in the realm of labour it was exactly the coordination of organizing and executing actions in their inseparable union that was typical. Generally, all actions were conceived in this way, not only socially-labouring individual human actions, but even all elemental actions. If the act of a man was not stipulated by the instructions of another person (the organizer), it was taken that the man instructed himself, that he was his own organizer; thus there appeared in him two sides--the organizational or leading, and the executive or passive; the first was called the soul, the second the body. The same was true of any complex of external nature: animal, plant, stone, stream, heavenly body, all that was perceived as something active--and nothing else existed for primitive thought--all was mentally organized according to the scheme: "soul-body." Consequently, the general unity of organizational methods was directly and naively acknowledged. And the method of thinking itself, as we have seen, was taken in ready form from the very place from which it originated; that is, from social practice and the sphere of production.

On this basis, the many errors and "superstitions" of our remote ancestors and contemporary savages become clear and natural. Such, for example, is the belief that incantations of magic words can affect objects of external nature and change the course of elemental phenomena. Human actions were considered to be determined by words; namely, by instructions or orders from the organizer. If it is believed that the organization of elemental actions is the same, then it is obvious that they obey words; but, to be sure, the words of a competent organizer spoken in an appropriate way, intelligibly for the object or the element in question. It is not in vain that "mir" (universe) in the Russian language properly denotes "commune;" for the naive consciousness the same connections and relationships exist in the commune as in the entire universe. This is an inevitable stage in the evolution of the organizational consciousness.

The original unity of the organizational point of view is preserved throughout the entire epoch of the authoritarian mode of life. Its worldview takes the form of "religions" which present the structure of the universe either according to a partriarchal, ancestral or feudal structure: in the earlier religions separate ancestral gods exist, then come tribal gods; in the more developed societies, there is a chain of many gods in which petty gods are the vassals and the more important gods their suzerains, and at the head stands the uniting god-sovereign; moreover, the subordinate gods frequently pay a tribute or bring sacrifices to the higher gods. The practical meaning of the bond between people and gods consists precisely in that the gods rule equally well over people and things and are able, within the limits of their field, to prescribe actions to things which are desirable and advantageous to people. The sacred books of these religions–as an example may serve the Jewish Bible,–present encyclopedias of the organizational experience of the times. In them is recorded the history of the world and mankind, geography, instructions on techniques of production, economics, the domestic relationships of people, political structure, worship, medicine and hygiene, etc. All of this was, from our point of view, stated quite disorderly, as things accumulated and were written down: sanitation is mixed up with worship and technology, politics with geography and the rules concerning family; but everything is deeply imbued with a naive unity of methods. And the laws of nature and the laws of the life of people are considered as perfectly homogeneous organizational prescriptions of the divine power, and all knowledge about them as its "revelation;" that is, as a simple communication or publication of those prescriptions. There is no thought that the processes of nature, elemental and social life can have their own laws, different for different fields of experience, that the subordination of facts to the known regularities and the obedience of people to authority are things of a different order.

Here, the growing, crystallising experience is always, as if automatically, complemented according to the same scheme: the sun daily performs the path from east to west because it was so instructed; sickness develops in a definite sequence because it carries out a corresponding command, etc. The widest, best understood truths in experience are the immutable prescriptions of a higher divinity. On their immutability is based the entire confidence of people in labour calculations and in planned efforts. Certainly, the divinity, as any other ruler, can in a special case suspend or revoke the action of the established law; but this will be an exception, a "miracle," a special intervention which, of course, happens very infrequently. Under this concept are placed the seeming disturbances of the customary truths of life such as earthquakes, unprecedented epidemics and destructive floods, etc. Thus the very idea of regularity is not undermined by them; the notion of a "miracle" serves as a sort of protection for its evolution, removing from it all that cannot be put into man's as yet too weak cognition.

ii. The Unity of Organizational Methods in Generalizing Sciences

The initial unity of the organizational point of view was based on human weakness in labour-experience and on the homogeneours authoritarian structure of society. Evolution, by overcoming this weakness and creating new social relationships, led to a break-up of the original unity, to a splintering of experience and to a change of its entire bond.

The division of labour became the foundation for a transformation of the social life of people, generally, and thought in particular. Step by step, specialization was strengthened; it narrowed the field of work for separate individuals, but in return it raised the productivity of work,and facilitated and accelerated the accumulation of experience. A blacksmith, tailor, and farmer, each in his own sphere mastered with the greatest fullness the ways and conditions of production bequeathed by ancestors, but he himself little-by-little, at first imperceptibly and later consciously,perfected and amplified these methods. Even more easily and frequently,a similar progress occured through borrowing from the inhabitants of other regions and countries; this became possible with an exchange of goods engendered by the very division of labour. In both cases, the old organizational point of view could not be retained; perfected modes and technical organizational rules were not now prescriptions and revelations of gods: if they were produced independently, the absence of divine intervention was obvious; if they were borrowed from without, then to submit to them as commands of *alien* gods was inadmissible, and it was only possible to receive them as useful knowledge and no more.

Thus arose, side by side with the former sacred and conservative thought, different knowledge which was secular and progressive. It was naturally gathered and accumulated into branches of labour to which it referred: knowledge concerning agriculture, smithy, etc. It was transmitted orally and practically from parents to children and from masters to apprentices. But as its mass grew this became insufficient; it was written down and, at the same time, brought together into a system, but of a completely different kind. It was now organized in a way which permitted as little expenditure of labour as possible for its mastery and retention, according to the principle of the "economy of effort." And this is a *scientific* principle; experience began to be organized into science or, more precisely, into separate sciences. Agricultural knowledge became the material for agronomy, the science of farming; blacksmith's knowledge became the material for metallurgy; that of mining for the science of mineralogy, etc. These are, as we can see, technical sciences. Their number grew with the ramification of social labour and the gathering of experience in all branches of knowledge; there are hundreds of them today.

This certainly does not mean that technical knowledge of one branch is applicable to that branch only: the actual unity of human labour rules over its formal division, and organizational methods often prove to be suitable far beyond the limits of the field for which they were originally formed. For example, land knowledge was concerned with both land measurement and the numeration of time. Land measurement is generally necessary for the distribution of plots in farming and for the requisite calculations concerning quantities of required seeds and quantitites of expected produce, etc. In countries where high forms of agriculture were first developed--in the flooded and fertile valleys of the great rivers of the Nile, Tigris, Euphrates, Indus, Ganges and Yangtze-Kiang – land measurement was even more necessary in order to reestablish each year the plot borders which had disappeared in floods. However, methods of land measurement did not become a simple part of the science of farming. These methods– the measurement of lines, angles, figures, and the explanation of their mutual relationships and dependence–

proved to be also widely applicable to engineering and the construction of canals, bridges, sluices, great roads, all kinds of buildings, and subsequently to the blacksmith-instrumental area as a means of establishing precise devices; to optometry for polishing the lenses of eye-glasses; to art as a basis of perspective; to the jewellery business for the polishing of stones and to military technique for taking a precise aim, etc., without end. Methods of land measurement spread to all the fields of labour and life and, therefore, could not remain as the applied knowledge of one field; under the name of "geometry" they became a special science of a *general* or "abstract" character.

From the very beginning, agriculture required a correct calculation of the time in the year, that is, a "calendar." This calculation is only possible by reference to the sun and other heavenly bodies, by observing the periodicity of their locations. In countries of the great river civilizations, these methods had to be developed to a high degree of precision, because with the elemental course of floods and their dependence on solar heat at the riverhead and over the entire stretch of the river, any, even the slightest, error in the calculation of time could be fatal to the mass of people and their economy. Thus astronomy was born in agricultural practice. But again its methods and modes did not remain within the limits of farming, but found a wide application in all branches of social life. Calendars and the calculation of time are necessary everywhere, especially in the technique of communication where distances are calculated by reference to time; besides, only with reference to astronomical bodies it is possible to establish the precise direction at sea or in the steppes; and later it was by reference to these bodies that man learned how to calculate with precision locations in space— longitude and latitude, without which long voyages are unthinkable. And with the transition to mass production, and especially to machine technology, all organization of labour requires the distribution of time in hours and minutes, and sometimes in seconds; and this concerns not only the timetable of railways and trams, but also many other chemical and metallurgical processes as well. Among other things, the precise examination and coordination of innumerable hours, according to which the life and work of people are organized, is achieved only through astronomy. Through these methods is developed the only general system of measures, the metric system. The meter is a forty-millionth part of the earth's meridian, which is the basic measure of the entire system; but it is only possible to divide this measure into parts with the aid of astronomy and geometry. Consequently, astronomy serves as a means of organizing not only separate branches, but the entire production as a whole; it is a means of orienting human efforts in time and space.

The science of accounting (calculation) has an even more common character: all labour processes, merchandise and monetary circulation, and all economic structures of society are based on the calculation of the labour force, labour hours, quantity of materials, instruments, and products, on a variety of arithmetical, algebraic and statistical computations. Here before us is also , obviously, a general organizational method in the form of an abstract science.

The same can be said of other general sciences. It is not possible to point to a branch of production in whose organization are not used the data and methods of mechanics, physics and chemistry— the sciences about the resistances and activities of external nature encountered by any human exertion. Logic is the science for the regulation of any collective discussion or reflection, which in the final analysis always serves as a means for the subsequent organization of efforts. The life sciences are the instruments of the control, coordination and harmonization of all the living processes of man himself, man as a labour force, his domestic animals and cultivated plants, and also as an instrument for the technical subordination and use of any other life in nature. The social sciences are a means of introducing regularity into any collaboration of people, etc.

Consequently, the generalizing sciences are in themselves the embodiment of the unity of organizational methods in the entire splintered system of collective human activity. Despite this, their development did not lead to the maintenance and strenghtening of the unifying organizational point of view. On the contrary, with the growing specialization of society and the accumulation of facts, they were *isolated into separate sciences;* and later they disintegrated into finer specialities, the number of which is now enormous. This splintering of science complemented and strengthened the operation of technology, with the result that the former naive unity of the organizational point of view disappeared from the social consciousness, and nothing new appeared in its place. The world of thought became as uncoordinated and anarchical as the world of practice: their mutual bonds and the bond of their parts in reality, of course, did not cease to exist, but were concealed and disguised by formal separation. Such is the organizational experience of the bourgeois world, and such is its science.

iii. Popular Tektology

No specialist can live completely and solely within his speciality; as a result of contact with other people his knowledge and experience inevitably go beyond its boundaries. For example, as a consumer he must have an idea about the variety of different products of other branches of labour; as a father and husband, about the consumption needs of his family and the upbringing of children; as a citizen, about the matters of state, etc. But while in his own specialization he aims at a precise formulation of his experience, at its certainty, completeness, harmony and at its scientific organization, in all other fields he is satisfied with minimal, fragmentary knowledge and with uncertain, vague, "narrow" or "worldly" experience.

This worldly experience plays a tremendous role in life and serves as a strong cement for the uncoordinated and anarchical collective. And besides, this experience is comparatively homogeneous and uniform for all the people living in the same social environment. In spite of the lack of a scientific basis, it is distinguished by the breadth and common elements of its content. It relates to the most disparate aspects of life: to the organization of things, at least, in a domestic situation, to people in a family, to everyday relations with neighbours and others, to the organization of ideas and to so-called "social opinion."

In this worldly experience, which is not complete or scientifically formed, but many-sided and practically-vital, is retained a naive unity of the organizational point of view; it represents an elemental but a deep tendency toward the unity of organizational methods.

General language serves as its main storehouse. True, also in this field, because of specialization, separate, partial branches, such as the technical language of this or that profession and the terminology of this or that science are set apart as boughs in a tree;and social class divisions create even a wider divergence between the dialect of the ruling classes and the dialect of the subordinated masses. But there remains a substantial nucleus of language which forms an indispensable connection between groups and classes and a condition for a sufficient mutual understanding in their practical intercourse. In it are crystallized the elementarily formed traditions of the past and the experience of millenia.

General language in all its breadth preserves the basic metaphor. In it, judgments or "suggestions" concerning human and social actions are organized in the same way as those relating to elemental activities. For example, the "subject" of a sentence can be an animate or inanimate object, concrete or abstract, a symbol for the body, process or action; the same verb and the same adjective can appear as a predicate with all these different subjects, that is, as their direct characteristic. Corresponding to the division of the ruling partiarchal family, all abstractions of the real world are to this day subdivided into male, female and sexually immature children; indeed, there is no other reason for the division of nouns into male, female and neutral genders. This distinctive monism can be easily traced throughout the entire grammar.

No less strange and even deeper is the same tendency in the "lexicon" of language, that is, in its word material. From the original roots denoting collectively-labouring acts, posterity developed thousands of word-concepts and spread them over its fields of experience, both physical and psychical. From the single and same Aryan root *mard*, whose general meaning is to break, smash, and through numerous transitions and interval shades arose such words as the Russian "molotok" (hammer), and "malii " (small), "smert' " (death) and "moree" (sea), "molodoi" (young) and "medlennli" (slow); the German "Meer" (sea) and "Erde" (earth), "Mord" (murder) and "mild" (soft, delicate), "Mal" (once) and "schwartz" (black), etc. In all of them there is revealed one and the same idea with sufficient study, which is of immense importance for the entire organizational experience— the idea of *division of the whole into parts*, in different aspects and applications. [1] In Russian, the verb "kryt' " (cover) is related to a great number of words : "kora" (crust), "koren' " (root), "korob" (box), "korabl" (vessel), "cherep" (skull), "cherepakha" (tortoise), etc.; in other Aryan languages there are also many such words; for example, German "Korb," French "corbeille" (basket), "ecorce" (bark), "croute" (crust), etc. In all of them is hidden the idea of one and the same organizational device, applicable both to technology and elemental nature: the idea of a linkage between the less stable, but more tender content, and the more solid casing which protects it from destructive external influences. From the Greek root " ag," which again spread into other kindred languages, originate such words as "tattein" (to build), "tekton" (builder), "taksis" (battle formation and, generally order), "tekhne" (trade, art), "teknon" (child), and a mass of other analogous words. With the greatest heterogeneity of these notions, all of them contain the general idea of the *organizational process*. [2]

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[1] For example, "malii" (small) is the result of division into parts; "molodoi" (young) is related to the meaning "malii' (small); "moree" (sea) is characterized by the greatest ease of division of its water; "Erde" (earth) means, first of all, soil, soft, loose, or easily separated; "schwartz" (black) and Russian "smol" (tar), "smola" (pitch) are related to the notion about smearing or staining with a substance which grinds or pulverizes.

[2] Therefore, I proposed to denote the general organizational science by the word from the same root—"tektologia". Hegel already used this word, but only in relation to the laws of organization in living beings.

The *word* often preserves its organizational idea where the splintered thought of man has already lost it. For example, the organizational role of religion in social life slips away completely from the everyday and average consciousness of our epoch. Meanwhile,the very word quite clearly points to this role, whether it originates from "religare" ("to bind" in Latin), or from "relegere" ("to gather"). Analogously, if not the content, then the use of the word "dusha" (soul) in Russian and other kindred languages, if carefully traced, provides a clue to one of the darkest secrets of science and philosophy. It is often used in the sense of "organizer" or "the organizing principle;" for example, such and such a person is "dusha" (the soul) of such a business or society; that is, he is an active organizer at work or the life of an organization; "love is the soul of Christianity," that is, it is its organizing principle, etc. It is clear from this that "dusha" (soul) is contrasted with the body precisely as its organizer or organizing principle; that is, that we have here a simple transfer on man or other things of the notion about a certain form of cooperation which involves the separation of the organizer from the executant, or authoritarian labour relations. This is the real solution to the problem concerning how the idea of the "soul" originated. In this instance,as in many others, the collective genius of language happened to be superior to the individual efforts of scientists and specialists, the children of the splintered, anarchical society.

Furthermore, worldly experience is preserved in more complex forms of so-called "popular wisdom:"in proverbs, parables, fables, and tales, etc. Many of them are expressions of the widest laws of organization in society and nature. For example, the proverb "where a thing is thin, there it breaks" is a pictorial and unscientific but true expression of the most general law, according to which disorganization occurs at all levels in the universe. Whatever entity there may be, it starts to disorganize if only at one of its points the resistence happens to be insufficient as compared to the activity of an external force: in the case of a fabric, where it is the "thinnest;" the chain, where it is not strong enough or has a rusted link; the organization of people, where its connections are weakest; the living organism, where its tissues are least protected; a scientific or philosophical doctrine, where the joining of concepts is vulnerable to criticism, etc. The proverb "strike the iron while it is hot" is by no means only a technical rule for the trade of a blacksmith; it is also the principle of any practice and any organizational or disorganizational act; it points to the necessity of utilizing favourable conditions in view of their limited duration and the irreversible meaning of their loss. This rule is equally important to a farmer as far as conditions for sowing or reaping are concerned; and to a politician or a strategist in respect of changing combinations of social or fighting forces; and to an artist or researcher in the sense of a lucky combination of external circumstances or psycho-physiological conditions, so-called "inspiration," and to a person in love, etc.; the proverb about the twigs which are easily broken by a child, and about the wreath made of them which cannot be broken by a strong man, is a popular expression of the idea of organization; it is equally applicable to people, things and ideas. To be sure, not all of the embodiments of popular wisdom embrace so widely and deeply the organizational experience; nevertheless, all of them relate to it not just in the narrow specialized sense, but more generally by means of a difusion through the limits of separate branches of everyday practice and thought. However, this monism of "popular tektology" is not able by itself to struggle against the spirit of specialization. With technological and ideological progress, it increasingly gives in to the ascendancy of specialization over social consciousness. The fact is that worldly wisdom is not only unscientific in its form, but also deeply stagnant in its basic tendency; it belongs to the past and aims to preserve it; in contrast, specialization appears to be a progressive line of life. However, by destroying this naive and conservative monism, specialization calls for the birth of another monism which is scientific and progressive, and as superior to it as it is superior to popular tektology.

iv. Specialization and Transfer of Methods

Specialization has led to a tremendous development of the collective forces of mankind in labour and cognition. It has had, however, a *limited motive-power for progress.* Along with conditions facilitating and accelerating progress, specialization also contains retarding conditions; at first, their impact was negligible, but in the course of time this impact has grown to such an extent that now it is being converted into the present deep contradiction which costs mankind so dearly.

The benefit of specialization arises, first of all, from the economy of efforts. The worker does not scatter them in various directions, but concentrates them in one; as a result, their action turns out to be more considerable, precise and perfect. Because the field of organizational experience is narrower, mastery over it becomes easier; the acquisition of skills and methods becomes faster and more successful. Nevertheless, along with the economy of efforts goes their dissipation, which is at first imperceptible, but inescapable from the very beginning. It flows from a weakening of the bonds among people and the connectedness of their experience.

This, first of all, is quite clearly displayed in the sphere of language. Because of the separation of fields of knowledge, things which are quite homogeneous receive different names, and thus the complexity of language and the expenditure of energy by each member of society in order to master it grow considerably. And this particularly refers to what is most frequently repeated in experience and, this means, that which is most frequently found in speech. Thus, "death" in our language is denoted differently: when it refers to people, we use the word "to expire;" to animals, "to perish" or "to die" when it predominantly concerns domestic animals; when it refers to fish, the fisherman says "to fall asleep," and for crabs the special term is used, "to stop whispering;" that is, to cease the rustling peculiar to them, etc. Most striking in this regard is the existence of a multiplicity of words expressing the organizational process. We use the word "to organize" mainly in connection with people and institutions. For products of labour the general term "to produce" is used; but its meaning is exactly the same: to organize definite elements— in this case the elements of the external environment— into a combination which is planned in advance. But in the construction industry the term "to build" is used; for example, to build a house or building; and even in each of its branches a special word is used; for example, in the case of a railroad, "to lay" the railroad denotes the entire organizational process of railroad building, as can be seen from the fact that the word "to build" is also naturally used there; but the use of the words "to produce" or "to organize" would sound quite strange, though the idea would be no less precisely expressed, and the entire special character of the process could be adequately pointed out by the addition of the word a "railroad." In the case of products, such expressions as "to manufacture," "to prepare," "to execute," etc, are also employed. But in addition, the same meaning is expressed by a mass of special verbs in narrower branches: in the case of clothes, "to sew;" moreover, by no means only a mechanical act of sewing is implied here, but the entire complex organizational process in which sewing is only one of the operations; in the case of weapons, "to forge," paintings, "to draw;" books, "to write," etc. Futhermore, there is a whole series of words relating to ideological acts of the same kind; for example, "to create" a work of art; "to write" a treatise or a book, a novel or a play; "to invent" an apparatus (with the shade of meaning of organizing for the first time); and "to discover" a law (organization of facts into a definite scheme). Sometimes, a designation is taken form the sphere of concepts of the opposite character, relating to disorganization: "to break a camp" or "to break a garden," in the sense of organizing with a requisite disposition in space. The most general term of human practice, "to do," means at the same time " to organize" and "to disorganize."

Elemental-organizational processes are partly expressed with the same words, partly with special ones, and in different scientific branches by a variety of words. Such are the physio-chemical terms "generation," "formation" and the biological terms "adaptation," "evolution," used with many changing shades of meaning. In psychology, organizational processes are frequently called "associative." In the social sciences the terms which are taken from the construction business preponderate ("to build a society," "to establish an enterprise," etc.); but there is also used, without a noticeable discrimination, the word "to organize;" strictly speaking, it refers to the sphere of technical knowledge and in Greek means "to supply with instruments."

Certainly, the majority of concepts are not expressed in so many different words; but nevertheless, a great deal of unnecessary expenditure of energy is quite evident in the development of speech and, particularly, in learning a language. Besides, specialization engenders still another contradiction: with the divergence of branches of knowledge the same words acquire different meanings; this creates confusion and mess when branches come into contact. Consider, for example, the scientific term "competition." In political economy it means the market struggle of sellers in the course of selling their goods, or of purchasers in the course of acquiring goods when there is no correspondence between demand and supply; this is a struggle on the basis of social relations and it camouflages the cooperation among members of society who are working objectively not for themselves, but for the social whole. In biology, the same term expresses the everyday struggle among organisms for the nourishment which is limited in nature; thus plants in a forest stretch their branches and leaves upward to the sunlight, the main source of their energy, and their roots as deep as possible into the ground, from which they extract water and the indispensable salts, meanwhile smothering each other. These are quite different relationships, but because of the common name, they are often not distinguished; and their confusion became the theoretical basis for an entire school of "Darwinian sociologists" who transferred onto social life the concepts of biological struggle.

Specialization in itself engendered the *divergence of methods*; leading an isolated existence, the separated branches of knowledge developed these methods in various ways. And insofar as common methods were preserved or even appeared independently in isolated fields, a special language, concealing this fact from the consciousness of people and impeding the economy of effort, forced the mastery of one and the same method under different names; and in other cases the specialized language was harmful to the necessary precision because of the divergence in the meaning of the same terms. Hence we have an unnecessary expenditure of social energy which, with the progress of specialization, has increasingly grown in size and has increasingly weakened its positive role.

The divergence of the experience and methods of different branches leads to a narrowing of the horizons of specialists and undermines organizational creativity. Having at their disposal,in islolation, only a negligible part of the accumulated methods and points of view of society, and not having an opportunity to choose from among them and combine them in the best way, specialists cannot cope with the continous accumulation of material and harmoniously and holistically organize it. The result is the piling up of material in an increasingly raw from, often stifling by its quantity. Its mastery becomes increasingly more difficult; this compels further splintering of branches into even smaller parts, with a new narrower horizon, etc. This was noted long ago by the leading scientists and thinkers who led the fight against "shop-narrowness,"mainly in the field of science.

But splintering was not absolute; from the very beginning there was another tendency which was not noticeable for a long time because of its weakness, but which has continued to force its way and grow in intensity, particularly since the last century. Contacts among branches existed despite specialization, and the methods of some of them penetrated into others, frequently causing in them entire revolutions. In technology and in science, nearly all of the greatest discoveries came from the *transfer of methods* beyond the limits of the fields in which they originated.

Thus, the use of steam engines passed from one branch of industry to another, giving rise everywhere to a tremendous growth in the productivity of labour; in transportation, for example, it became widely applied only decades after the transformation of a considerable part of industry had already taken place. Subsequently, in the development of steam engines the application of the turbine mechanism was a great step forward; this mechanism was known for a long time in water technology (the simplest turbine is a toy called the Sygnerian wheel). Further, an even bigger step was taken with the introduction of the "explosive" principle, which for hundreds of years reigned over the technology of war and demolition. Engines constructed on this basis are distinguished by a gigantic force, despite their small volume and weight; they conquered airspace for mankind.

Precise methods of weighing were developed in the mining technology of precious metals, the jeweller's art and the preparation of medicines. Lavoisier, having applied them subsequently to chemistry, created a great scientific revolution when he applied these methods. The practical principles of machine production, which had been put on a scientific basis by physicists, were transformed into thermodynamics and later into general energetics; the latter forms the basis for the most recent union of the physical and chemical sciences. Astronomy was transformed by the principles of mechnics, and the methods of physics and chemistry made physiology into a precise science. Psychology is changing its character in significant ways thanks to the methods of physiology and general biology which have also introduced scientific precision into it.

The transfer of methods objectively and immutably demonstrates the possibility of their development towards unity, towards a monism of organizational experience. But this conclusion is alien to the consciousness of the specialist, and generally to the ordinary consciousness of our epoch. Every step which brings us closer to this unity meets, at first, fierce resistance from most specialists; the history of science is full of examples to support this. Later, when the unifying idea gains victory and is accepted by specialists, this by no means lessens their resistance to the next step. This resistance flows from the very mechanism of thought engendered by specialization. The mechanism is such that the specialist unwittingly aims to separate the field of his known and habitual work from the rest of experience, foreign to him and arousing in him the feeling of uncertainty; where the boundaries are broken, and fields and methods of work draw closer together, the specialist senses an intrusion of something strange, even hostile, into his private business, and the mastery of this new knowledge is more difficult for him than the following of the old, well-trodden paths. This is why, for example, the law of the conservation of energy, which was one of the widest and deepest of ideas unifying the sciences in the XIX century, had to force its way for such a long time until it was recognized. The article by Robert Mayer, the first to express and validate this law clearly, was rejected by the specialized journal of physics. Darwinism had to suffer no less a struggle. When the physicist Yuz accidentally discovered electrical waves with the aid of his microphone, which transmitted fluctuations of electrical discharges occurring in his laboratory to him in the street, his friends were able to persuade him not to publish this fact and his conclusions: they said that by doing so he would "scientifically compromise himself." And this discovery, merging the phenomena of light and electricity, had to be made again by Hertz a quarter of a century later.

Even such essentially practical ideas as the application of the force of steam to water and land transportation, when it was already applied as a motive power in industry, aroused distrust and mockery from authoritative people in the form of statements such as "this is as likely as travel on Congreve's rocket." For a man brought up in the spirit of specialization, it was obvious that methods suitable for the factory cannot be suitable for the ship and the carriage. By the way, the "explosive" principle on which the rocket is based was subsequently applied to the organization of transport technology; and, of course, in a correspondingly changed and adapted form, to automobiles, motor vessels, aeroplanes and dirigibles. Similar facts can be cited without end.

v. Contemporary Thought and the Idea of the General Unity of Organizational Methods

The unity of organizational methods, forcing itself through the narrow framework of specialization, is imposed by the newest developments in technology and science. The methods which are used by contemporary thought, both popular and scientific, to rid itself from this unpleasant and strange point of view are quite characteristic. First of all, the very concept of "organization" is applied only to living beings and their classifications. Even technical processes of production are not recognized as organizational. To this thought is inaccessible, as if invisible, the simple fact that any product is a system organized from material elements by means of joining them with the elements of energy of human labour; that, therefore, all technical knowledge deals with the organization of things by means of human efforts and in human interests.

As far as products of the elemental forces of nature are concerned, the living "organization" is opposed to the dead "mechanism," as if it were something different and separated by an impassable gulf. Meanwhile, if we carefully study how the notion of "mechanism" is used in science, then the gulf immediately disappears. Each time a function of the living organism is explained, it is considered to be "mechanical." For example, breathing and the activity of the heart were considered for a long time to be the most enigmatic phenomena of life; when they were understood they became for physiology simply "mechanism." The same thing occurred when the electrical nature of the neural current was explained: the transmission of neural stimulations from sense organs to the brain and the brain to muscles was seen as a "mechanism." Meanwhile, have these functions ceased to be a part of the organizational process of life, its indispensable and essential moments? Certainly not. The "mechanical side of life" is simply all that has been explained. "Mechanism" is nothing more than understood organization. A machine is "no more than a mechanism," because its organization is carried out by people and is , therefore, principally known to them. And our own body is "not simply a mechanism" for contemporary man for the same reason that the clock is not for the savage or a child; it is not a dead machine, but a living being. The "mechanical point of view" is the only organizational point of view in its development and in its victories over the separateness of science.

No matter how well the thought of the contemporary specialist is armoured against this point of view, he cannot but be struck by a growing application of similar methods and schemes in the most diverse branches of scientific experimentation. There appears to be a need to somehow understand this unity, mysterious to the specialized consciousness brought up on separateness, seeking limits, frameworks and partitions, but which is nevertheless unquestionable and unavoidable. It seems desirable to understand it in such a way as to soften it, to weaken its significance, to find that it is imaginary, seeming, subjective, or artifical, that it is not at all rooted in the very nature of things or in real existence. The thought of those philosophers who were imbued with the spirit of specialization, that is, most of them, worked in this desired direction. They were able to create two theories suitable to this problem and to their own inclination.

The first, Kantian, asumes that the entire unity of schemes and methods depends entirely on the perceiving subject; that is, it is completely "subjective." Man can think only in definite forms which are primordially peculiar to the very nature of his cognitive abilities. These forms he imposes on facts, and later on reality and the nature of the explored world. This leads to an illusion: man, in the words of Kant, "prescribes laws to nature," but only in the sense that these laws are those of his own cognition, which he cannot avoid and whose limits he cannot cross; he puts into them his experience because he himself is constrained by them and knows no other laws. To him everything appears as occurring in time, space and causal relationships, but all of this "seems to be so," is only a "phenomenon"(semblance, appearance); these "forms" are contained in the subject and not in the things "themselves," not in the object. Such is the essential idea of the old epistemology, or theory of knowledge.

Here, for example, is how this point of view is used in the atomic theory of the physio-chemical sciences, and how notions in other fields are related to it: "the atomic hypothesis is psychologically indispensable. Continuity cannot be comprehended without dividing it into parts; hence, the notions about time, space, a straight line as an element of a curve, about an atom, about a cell as a biological atom, about man as a social atom, etc. *The atomic hypothesis expresses not the structure of bodies, but rather the structure of our cognitive ability.*"[1]

In connection with the hypothesis of Crookes concerning the primary substance or protyle which in the course of "aggregation," that is, condensation through regroupings into tighter combinations, created chemical elements (according to the contemporary views, this protyle turns out to be atoms of electricity, negative and positive), the same author says: "Protyle, even if it existed did not have an urge for aggregation, but Crookes had an urge to aggregate protyle in order to somehow represent the origin of matter from the primordial substance." [2]

Strained interpretations in such discourses can quite easily be discovered. It is already erroneous to perceive "atomicity" in the notions of time and space. The atom is that which cannot be divided into parts; this division is either absolutely impossible or impossible without changing the very nature of the thing divided. And time and space, according to contemporary scientific thought, are characterized exactly by the fact that they can be divided without limit; that is, they are not "atomic." But this is not the important thing.

Let the living cell be a biological atom; it is therefore "psychologically necessary" to acknowledge its separateness. But was it not necessary to *see the cell* under the microscope? And was the cell really seen because of this "psychological necessity?" On the contrary, it was not until the cell was discovered and its changes and transformations were traced, that there was any thought about the cellular structure of living bodies. To be sure, they were represented as being composed of these or other elements; but there was not and could not be prior to such a discovery the unifying scheme of cellular organization.

Let us choose our own illustration. In the study of electrical and magnetic forces there is a widely used scheme: "attraction-repulsion." This scheme

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[1] M. Goldstein, "Osnovy Filosofii Khimii," (The Basis of the Philosophy of Chemistry), p. 57-58.

[2] *Ibid.*, p. 123.

is present in a mass of notions in other fields of science and life, ranging from molecular theories to the mutual relationships between animals of different sexes which are "attracted," and of the same sex which are "repulsed," or to human characters, or to psychic images in consciousness, etc. Obviously, it also expresses "not the structure of things, but a structure of our cognitive ability" which is also "subjective;" that is, it depends on the perceiving subject. But if it does not depend on the "structure of things," it must be applicable everywhere: wherever there is the "phenomenon" of attraction there must also be, under appropriate conditions, the "phenomenon" of repulsion. Unfortunately, this is not true of planetary attraction, the same attraction which in an unpleasant way chains us to earth. "The structure of our cognitive ability" which "aims" to complement attraction with repulsion cannot provide us with the most important *fact* needed here. It is clear that "the structure of things" is also present here; that it is possible "to prescribe the laws of nature," but only by an agreement with it.

It is true that there exist certain *forms of thinking* which people use to store their experience; but this has nothing to do with some age-long "structure of cognitive ability," but simply with modes of organizing experience; they develop and change with the growth of this experience and the change in its content. To an animist savage "the structure of cognitive ability" requires that every moving object— man, animal, sun, stream, clock, and all things in general— to have its own "soul;" and for us this kind of thinking is dying off. For us, time and space are infinite; but this was not yet so in antiquity. "Atomism" originated in ancient thought when *individualism* developed in society setting men apart. People were accustomed to think about themselves and others as isolated entities, and they transferred this habit onto notions about nature: in Greek, "atom" means an "individual," and in Latin it means "indivisibility."

Once at the home of a philosopher I saw a child, his son, designate the big table and a stool by the words "table-papa" and "table-baby." The philosopher should have understood by this example what is meant by "forms" or "categories" of thought. The narrow experience of family life gave the child a habitual connection between similar objects of different size; this connection entered into the "structure of his cognitive ability," and the child endeavoured with its help to organize his further experience. In a similar way, the savage living in a commune which is organized on the basis of authoritarian leadership and passive submission, thinks, that is, organizes in his consciousness, of the entire universe in the same way: he thinks of the ruling "god" and the people and things subordinated to him; and he organizes them in his thought into the ruling, leading "soul" and the passive "body." In a similar way, the individualistic separateness of life gave philosophers a scheme for the atomic separateness of the elements in the universe, etc.

The main point is simple. All these unifying schemes are means of organizing experience; its instruments or "forms." The instrument of organization certainly depends on who organizes or develops the instrument and uses it, and on what is being organized; that is, on the material of experience. Thus, the instrument of labour must correspond in its structure to the hand and strength of the worker, and to the properties of the object being worked on by the instrument: a fine instrument which is suitable for the trained European worker is useless in the hands of a savage, and the instrument which is appropriate for the grinding of iron is unfit to work on wood. In this regard, there is no essential difference between material and abstract instruments, as there is also no difference in relation to the historical changeability of both.

The second point of view on unifying schemes can be called "philological" or "symbolical." It is very close to the first and reduces the origin of these schemes to language, words, and to the working out of similar designations or symbols for the various fields of experience. Here is an example of such an interpretation.

"One and the same equation— the Laplacian,— is encountered in Newton's theory of gravitation, the theory about the motion of liquids, the teaching about electrical potential, the teaching about magnetism and the diffusion of heat, to name a few. What conclusion can be derived from this? These theories appear to be copied precisely from each other; they illuminate and elucidate each other and borrow their language from each other. Ask specialists in electricity what service has been brought to them by the invention of the term "the flow of energy" suggested by hydrodynamics and the theory of thermal heat... etc."[1]

The main thing lies here, perhaps, in a lack of understanding, because the question is not put why one branch of experience can borrow its language from another, and why "terms" take on such a force. It is suggested that this force is inherent in the symbols themselves, and that the "common language" is a sufficient explanation. In fact, it is not at all like this. The use of common terms sometimes only brings

[1] Henri Poincare, "Tsennost' Nauki," (Value of Science), French Edition, p. 146.

harm to understanding and clarity, as we have already seen in the example of the notion of "competition" in the general teaching about life and political economy. Also, the usage of the same language, as that used for individual organisms, by the school of "organicists" in the field of social structure and life bestowed little benefit on science and created a lot of confusion instead. It resulted in a search for various organs and tissues in society, similar to the tissues and organs of the living organism; besides, artificial connections were also created, and strained interpretations were made, instead of the really general organizational schemes.

In reality, common language is compelled by the unity of organizational methods or forms to express this unity. It is worked out everywhere only later, after this unity is revealed. In many cases, where this unity already strikes the eye, common terms still do not exist; due to the specialized language they remain different.

Thus, the usual structure of the vegetable seed and the egg can serve as a striking example of the coincidence of independently established organizational forms. In both cases there is an embryo which is surrounded by a noursihing layer, then by a coarser casing of the "skeletal" type. Frequently, nutritious layers are even analoguous in terms of their chemical substance, one with the preponderence of nitrous substances, namely albumen and closely related bodies, the other with the preponderence of non-nitrous substances, fatty and sugary substances in the egg and oily and starchy substances in the seed; besides, the arrangement of layers is often different. The unity of the structural scheme was noted long ago; but common terms were only gradually created, and were mainly due to the development of organic and physiological chemistry.

Another illustration: in the female flower, the central place is taken by the canal which serves as the path for fertilization. In front, it is surrounded, first of all, by folds of tissue of a more delicate texture; then by a coarser texture("petals of corola" and a "cup"). In the depth of it, where the development of an embryo takes place, an organ ("pistil") of a more or less pear-shaped form is contained. Exactly the same description of this architecture, with the exception of botanical terms, may be applied to the female organs of a monkey or a woman. But it is clear that the "unity of language"here too leads only to the question concerning the unity of structural scheme, and hence it does not exhaust the subject.

Despite innumerable parallels and coincidences in the most varied spheres of experience, the old world which was anarchically splintered at its social base could not arrive at the idea of a general unity of organizational methods--at the problem of the universal organizational science.

vi. Proletariat and the Universal Organizational Science

Mankind needed a new point of view on a universal scale; in other words, *a new mode of thought*. But historical changes in thought occur only when a new organization of the entire society develops, or when there appears a new social class. In the XIX century exactly such a class came into being— the industrial proletariat.

Its everyday relationships and its conditions of labour and struggle contained the conditions giving rise to that mode of thinking which was previously absent, that point of view which had not yet developed. Time was necessary to develop it, to realize it, to express it. But now this point of view is sufficiently clear and its bases are obvious.

The impediments to the development of monistic, scientifically organized thinking were specialization and the anarchically splintered system of labour. The proletariat, under machine production and the generally stable conditions of its social life, had a point of departure for overcoming the spirit of specialization and anarchy.

With the perfection of the machine, the role of the worker changed its character. The deepest separation within the scope of collaboration was that which isolated the organizer from the executant, and mental from the physical exertion. In scientific work, the labour of a worker embraces both types. The work of an organizer is *management and control* over implementation; the work of an executant is *physical influence* on the object of labour. In machine production,the activity of the worker is *management and control* over his "iron slave,"the machine, by means of a physical influence on it. Here the elements of the labour force are the same as those which were required before for the organizing function only, such as technical competence, understanding, initiative in the case of breakdowns, and also those which characterized the executing function, such as dexterity and speed and efficiency of action. This combination of both types is only faintly expressed at the very beginning of machine technology when the worker was a living appendage to the machine, when he complemented its coarse, simple movements with the mechanical skill of his hands. It appears more sharply and definitely as the machine is perfected, becomes more complicated and approaches closer and closer to the type of an "automatic," self-activating mechanism where the essence of work lies in living control, timely interference and constant active attention. This combination will be fully completed when even a higher form of machine is worked out--the self-regulating mechanism. This, certainly, is the business of the future; but even now the unifying tendency stands out quite sharply, so as to paralyze the worker's thinking about the former break between "mental" and "physical" labour.

Also, the other separation of workers is gradually overcome; that is, their technical specialization. "The psychological content of various labour processes becomes more and more homogeneous; and specialization is transferred to the machine or the labour instrument. But as far as distinctions in the experience and feelings of workers tending the machinery are concerned, they dwindle in scope and, with sophisticated technology, become negligible in comparison with the sum total of experience; identical features become a part of the content of labour: observation, control and the direction of the machine. With this, specialization, strictly speaking, is not destroyed; in fact, branches of production are not merged and each has its own technique; but it is *surmounted*, and loses its harmful aspects; specialization ceases to be a net of partitions between people; it ceases to constrain the workers' horizon and limit their interaction and mutual understanding."[1]

As far as social anarchy is concerned, which arose out of division of labour, competition and struggle of man against man, it also loses its divisive influence with the growth of the labour class, because this anarchy is removed from the worker's environment. Comradely contact at work and common interests with respect to capital rally the proletariat around various class organizations, which will gradually but inevitably lead to a world union.

The working class carries out the organization of things in its labour, and the organization of its human forces in its social struggle. It must connect the experience of both fields into a special ideology; namely, the organization of ideas. Thus, life itself makes the proletariat an organizer of a universal type, and the organizational point of view is a natural and even necessary tendency for it.

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1 "Voprosy Sotsialisma" (Questions of Socialism) A. Bogdanov, pp. 12-13, from "Kollectivnii Stroi" (Collective Order), Vol. II, "Politicheskaia Ekonomia" (Political Economy), Bogdanov and Stapano , fourth edition.

This is reflected in the ease with which the worker frees himself from the shop prejudices of his profession, in the passionate aspirations of the vanguard of proletariat to encyclopedic knowledge, and in its willingness to absorb the most monistic ideas and theories in all fields. But this does not mean that the new point of view, appearing in a mass of individual cases, can be easily and readily realized in its gigantic embrace and formed in its entirety. The industrial proletariat has been only gradually shaped into a new social type and reeducated by the force of the everyday relationships which befell it comparatively recently. Ideology is generally the most conservative aspect of social nature; it is the result of a new mode of life, new worldview and new culture; it is the most difficult affair in the life of a class.

The great social crisis of recent years should provide the most powerful jolt to the realization and shaping of the general organizational point of view. Both parts of the crisis–the World War and the World Revolution arising from it–lead the working class in this direction by different paths.

The World War turned out to be the greatest school of organization; it called for an unparalleled effort of organizational abilities from any person or any collective which was directly or indirectly involved in the War, giving it an invaluable organizational experience. This experience is characterized by an exceptionally severe demand for the definition of a problem whose solution becomes a matter of life or death, and by the comprehensiveness of the problem. In a war situation it becomes necessary to organize, simultaneously and jointly, human forces, material means and even the ideology of a military collective, or what is called its "spirit." Besides, these three aspects appear in practice as equals; at every step each element can be substituted for the other. For example, deficiency in people is compensated either by a reinforcement of the technical means of destruction or by an ideological rallying of people, raising the fighting spirit of a military collective through inspiring and elucidating speeches and orders; deficiency in technical means is equalized by a replenishment of human material, etc. The unity of the organizational point of view intrudes here with the greatest force and creates an acute necessity for the unity of organizational methods.

The War was the first phase of the great organizational crisis; it called for the second phase, the Revolution. The Revolution forced the working class to organize hastily and intensively not only its own efforts; it was also put into an unprecedented position: at least in some countries, the working class was compelled to take over the organization of social life as a whole. This situation, whether it is temporary or final, has changed the scale of the organizational point of view for the working class from a limited to a universal one. The sharper the contradiction between the nature of the problem and the absence of a systematized organizational point of view, and between the habits and the methods of the working class, the greater appears to be the necessity to systematize it all, and the more vital becomes the need for a ***universal organizational science.***

Thus were created the fundamental preconditions of this science. Mankind travelled a long and difficult path to reach it. It is a completely human science in the highest and fullest meaning of the word. Its idea was excluded from the minds of the old classes by the divisibility of their existence and the separateness and one-sidedness of their experience. When the forces of history have pushed a new class into a new unifying position, then the time has come for this idea to be embodied in life, where it is a fore-runner and a mighty instrument for the actual organization of mankind into a single collective.

II

Basic Concepts and Methods

1. Organization and Disorganization

i. Organized Complexes and Activities-Resistances

The first attempts to define organization in precise terms led to the idea of ***expediency.*** The concept of organization related then, of course, only to living beings, and separate organisms were taken as the starting point of study. An expedient combination of parts and connections was not only obvious, but with further investigation appeared more fully and clearly, startling by its perfection.

The idea of expediency contains an idea of purpose. Organisms and organizations have their "purposes" and are structured accordingly. But the existence of a purpose presupposes someone who establishes and realizes it, a consciously active being, a constructor, an organizer. But precisely who posited those purposes for men, beasts and plants which are being achieved by their vital functions? Who established organs and tissues in conformity with these functions? This completely natural and common sense way of raising the question has immediately deprived any investigation of a scientific character and has directed cognitive efforts into the realm of metaphysics and religion, ultimately leading to the concept of a personal creator or god. And priests of all religions, Christian and non-Christian, to this day put the "expediency" of the structure of living beings at the base of their "apologetics," that is, the theoretical defense of religions.

With the development of science, however, it became clear that those correlations which are expressed by the word "expediency" could appear and evolve quite naturally, in the absence of any "subject" who consciously establishes purposes; that is, that there is an *objective* expediency. It is the result of a universal struggle of organizational forms in which "inexpedient" or "less expedient" forms are destroyed and disappear and the "more expedient" are preserved. This is the process of natural selection. And the concept of "expediency" itself essentially turns out to be only an analogy or, more correctly, a metaphor which is apt to lead to confusion. It is clear that the concept is unsuitable for the scientific determination of organization.

Attempts to define organization formally, as the harmony or correspondence of parts among themselves and the whole, also fail to solve the problem; this is simply a substitution of the word "organization" by its synonyms. It is necessary to explain the nature of this correspondence or harmony; otherwise, it is quite useless to exchange one label for another.

Biologists long ago characterized an organism as "a whole which is greater than the sum of its parts." Although they used this formula, it is doubtful that they considered it to be a precise definition, especially in view of its external paradoxicalness; it nevertheless has features which deserve special attention. It excludes fetish or the positing of purposes for a subject; and it does not end in tautology, or the repetition of the same meaning in different words. And its seeming or actual contradiction with formal logic does not of itself decide the question: limitations of the role of formal logic have been fully established by scientific philosophical thought.

What, strictly speaking, is meant by the words "an organism is a whole which is greater than the sum of its parts?" In what sense or respect is it greater than this sum? The question evidently concerns the viability of the living organism and its ability to struggle with the surrounding environment. In a separated state, parts of a complex organism possess infinitesimal viability or have their viability so lowered that its magnitude, if it were measurable, would certainly be much smaller than that of the corresponding living whole. A body deprived of a hand, and a hand cut off from it are a sufficient example of this. But to investigate the problem in terms of such complex systems as the organism, and in such relative and hard to measure magnitudes as viability, is most inconvenient; it is better to start with simpler combinations.

Such, for example, is elementary cooperation. Already the joining of identical labour efforts on some mechanical task can lead to the growth of practical results in a greater proportion than the sum total of these labour efforts. If the question concerns, for example, the clearing of a field of stones, bushes and roots, and if one man can clear in a day one dessiatine, [1] then two together may carry out in one day not a double amount of work, but more, 2¼ - 2½ dessiatines. With 3 or 4 workers, the relationship may turn out to be even more favourable; up to a certain limit, of course. But the possibility is not ruled out that 2, 3 or 4 workers may together carry out less than two, three or four times the work. Both cases completely depend on the mode of combination of given forces. In the first case, it is correct to maintain that the whole turned out to be *practically greater* than the simple sum of its parts; in the second, that it is practically less than this sum. The first is designated as *organization*; the second as *disorganization.*

Thus, the essence of these concepts reduces *to a combination of activities which are taken from its practical aspect*; and for the formula concerning the whole which is either greater or smaller than the sum of its parts to be completely clear, it is necessary to complement the formula by the word "practically." Then it becomes a simple expression of an obvious and indisputable fact. Nevertheless, from a logical point of view a partial paradox still remains in it; at least for average contemporary thinking. It can easily picture the case when the joining of activities lessens their practical sum: this occurs when activities counteract each other, completely or partly paralyze each other, destroy, or, in a word, mutually "disorganize"each other. But in what way can magnitudes be joined so as to *increase* their practical sum? At first sight we have the creation of something out of nothing.

In reality the riddle is easily solved; it is only necessary to visualize the organized activities together with those *resistances* which are being overcome.

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[1] Measure of land = 2.7 acres

How can two workers together clear the field not 2 times but, for example, 2½ times faster than one worker? In response, the economist would point to the following moments: first of all, the very conjointness of work acts on the nervous system of the worker in a revitalizing, encouraging way and thereby raises the intensity of his work; secondly, the joining of two forces makes it possible to overcome obstacles which cannot be overcome by one worker; and many obstacles, though not insurmountable but considerable for them individually, are overpowered much faster.

Let us investigate both of these moments, beginning with the second, which yields more easily to analysis.

Let the muscular strength of each worker enable him to lift and move a stone weighting 5 poods[1] and no more. Two workers can cope with a stone, of course, not of 10 poods, but only of a lesser weight, because it is not possible to combine efforts without a loss; that is, without some mutual hindrance. *This sum* will always turn out to be lesser than the result of a simple addition; let us assume that it is equal to 9 poods. In such a case, the stone weighing 8 poods represents a resistance, which is for a single worker either generally insurmountable or surmountable only with a change in the method of work, which means, at any rate, a considerable unnecessary expenditure of energy and a loss of time, for example, in splitting the stone with a hammer or constructing a lever to move it. The coordination of efforts of the two workers removes insurmountability or the need to change methods. If the stone is less than 5 poods, but close to this limit, then the individual worker is forced to apply the greatest effort to it, which sharply exhausts his strenght and forces him to spend more time; whereas for the two workers this weight is much below the limit, and they quickly remove it with an average effort.

As far as "psychic" influences on cooperation are concerned, they relate to the *inner* resistances of the organism. Labouring alone, the worker undertakes and carries out all actions on his own initiative and with his own stimuli; for each new act, he has to appropriately tune his nervous-muscular apparatus quite independently. In a joint effort, however, a considerable part of this process of

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[1] 1 pood = 16.38 kgs

adaptation goes on at the expense of imitation; that is, in a much more mechanical and automatic way; so that for the imitating worker the inner resistances of his organism are considerably smaller. The stimulating influence of the apparent success in work also contributes to the lessening of internal resistences, etc.

In general, we see that the whole matter reduces to a relationship between the activities which are being organized and the resistances they are directed against. The activities which are being organized do not combine without losses, so that taken by themselves, in the "abstract," their practical sum is less than their precise numerical addition whould have been: 5 poods and 5 poods gave us as a result 9 poods. But resistances either do not add up at all—the stone of eight poods has the same weight for one worker or two workers, or, if they add up, they do this less perfectly than the activities which are being organized. This can be observed in those inner resistances of the organism which are related to changes in the direction of efforts: if under conditions of independent transition from one action to another this resistance is equal to a for each worker, then for the two together it is not $2a$, because imitation appears on the scene, and for the one who follows the example of the other, this magnitude is considerably lessened: $a + a$ produces a practical sum of, for example, $1\frac{1}{2}a$.[1]

Thus, the organized whole turned out to be practically greater than the simple sum of its parts, not because new activities were created out of nothing, but because its present activities were combined more successfully than the opposing resistances. Our world is generally a *world of variety*; only differences in energy tensions are revealed in action and only they have a practical meaning. Where activities and resistances collide, the practical sum, embodied in actual results, depends on the mode of combination of both; and for the whole this sum increases on that side where the combination is more harmonious and contains fewer "contradictions." This also signifies a higher level of organization.

[1]On this relative changeability of resistances is based an interesting and important practical paradox. If *A* runs away, and *B* pursues him, then in the case of *full equality* of their energies and capabilities, the second will inevitably catch up with the first: *A* is forced to choose his path quite independently, change direction, react to all obstacles, while *B* in this or that measure is able to follow *A*'s example, expending correspondingly less energy.

Tektology is full of such paradoxes, showing the extent to which reality is not embraced by formal, abstract notions, such as mathematical equality, logical identity, etc.

An illustration from another field is the symbiosis of a unicellular infusorian with a unicellular alga which lives in it. The first belongs to the simplest of animals; it uses oxygen and discharges carbon dioxide; the second is the simplest of plants and contains green seeds of cholorphyll; it decomposes carbon dioxide at the expense of energy of the sun rays, uses this energy as a material for its tissues and discharges oxygen. Thus, a certain part of the activities, in the material form of this or that substance, lost by one participant in the symbiosis is directly acquired by the other, and vice versa; consequently, it is preserved in the symbiotic whole. It is clear that this whole has at its practical disposal a larger sum of activities than its separate parts would have had in isolation: it is a model of a widespread type of organizational connections.

ii. Disorganized and Neutral Complexes

In the foregoing discussion we were concerned with organized *activities* and the *resistances* surmounted by them. It is easy to be convinced that these are quite correlative concepts; in essence, they express one and the same thing and are everywhere substituted one for the other. If two armies or two classes are engaged in a struggle, then the activities of each side represent resistances for the other; the whole matter is but a question of the point of view taken. From the point of view of a hunter, who takes himself as the centre of observed facts, his efforts represent activities, and the efforts of all animals hunted by him represent resistances; but if we put the animal which is struggling for life at the centre of attention, then its efforts embody the activities of its organism. Again, in this sense there are no fundamental distinctions in nature between the living and the dead, the conscious and the elemental, etc. Formerly, there existed in science a concept of resistance which is not an activity; of the "inertia" which characterizes matter. This idea is now obsolete. Matter, with all of its inertia, is being perceived as the most concentrated complex of energy, that is, precisely activities; its atom is a system of closed motions, the speed of which exceeds all others in nature. Consequently, the elements of an organization or any complex which is studied from the organizational point of view are being reduced to *activities-resistances.*

The concept of "elements" in the organizational science is completely relative and conditional: it is simply those parts into which, in conformity with a problem under investigation, it was necessary to decompose its object; they may be as large or small as needed, they may be subdivided further or not; no limits to analysis can be placed here. Gigantic suns and nebulae have to be taken as elements of star systems; enterprises or individual people as elements of society; cells as elements of an organism; molecules or atoms or electrons as elements of a physical body, depending on the question at hand; ideas and concepts as elements of theoretical systems; representations and voluntary impulses as elements of psychic associations, etc. But as soon as it is necessary during the course of an investigation, practically or mentally, to decompose any of these elements further, it is considered as a "complex;" that is, as combinations and conjunctions of some elements next in order, etc.

Any decomposition of the whole into elements, actual or mental, is, of course, disorganization. Such decomposition is undertaken in order to lessen the opposition of things to our practical or cognitive efforts; this aids us later to organize elements into new and desirable combinations. ***The disorganized whole is practically less than the sum of its parts***; this definition flows naturally from the foregoing analysis.

With regard to the example from the field of cooperation, it was already mentioned that the common labour of two collaborators may turn out to be less than the sum of their separate labour forces. This is a case of disorganization: two workers do not help, but hinder each other. In a certain combination, their forces may be completely paralyzed; when, for example, they pull at a rope in opposite directions, the slight push of a child will put this entire system into motion. If, however, the forces of those pulling are expressed, for example, as 10 and 9 poods respectively, then the practical sum determining the motion of the system is equal to 1 pood instead of 19.

It is necessary to note that full, ideal organization is nonexistent in nature; disorganization is always admixed to it to some degree. Thus, even the best cooperation cannot be free from some, though minimal, inner hindrances and lack of agreement; the best constructed machine is not free from internal frictions, etc. Sometimes it is possible in the same system to observe factually all the transitional steps from the higher organization to the deepest disorganization; as happens, for example, with a gradually unfolding quarrel between close collaborators or between spouses.

A natural magnet, as is well known, is a piece of special magnetic iron-ore; it may be considerably intensified by joining to it a casing of soft iron, which is not magnetic by itself, or, more correctly, active magnetism in it is practically infinitely small. This vivid example of "inorganic" organization is explained by scientific theory in the following way. Particles of iron are not magnetic in themselves; in the soft iron they are disposed in complete disorder, directed in all possible directions, and their magnetic actions are mutually destroyed in this chaos. But when they fall into a sufficiently strong magnetic field; that is, into a sphere of considerable magnetic action having one difinite direction, then to a larger or smaller extent they turn or "orient" themselves to the line of this attraction, and their own actions are now added and do not destroy one another; the casing itself becomes actively magnetic as a whole and this intensifies the basic magnet. And here the whole matter reduces to a more perfect composition of activities, in which they cease to be mutual resistances. However, if we put together two fully equivalent straight magnets with opposite poles, then their magnetic actions will mutually paralyze each other and their practical sum will be close to zero. This is a disorganized magnetic system.

An extremely demonstrative and scientifically interesting illustration of the relationship in question is presented by the interference of waves, electrical, light, air and others. By superimposing one wave on another, the waves can intensify or weaken each other. Let two equivalent light waves flow so as to have the rise of one coincide precisely with the rise of the other, and consequently the valley of one coincide with the valley of the other. Then the common intensity of light received from both of them will turn out to be not double but quadruple: 1 + 1 is equal to 4. If, one the contrary, the rise of one wave fully merges with the valley of the other, and vice versa, then light and light together produce darkness: 1 + 1 is equal to zero. Between these two limits of organization and disorganization lie all the interval and that ideally average form, in which the intensity of light conforms precisely to the arithmetic: 1 + 1 = 2. This occurs when the rise of one wave half-way coincides with the rise and half-way with the valley of the other wave. Here correlations of organization and disorganization are mutually balanced, and the result is a neutral combination.

As we can see, only with the equilibrium of opposite tektological tendencies is "two times two equals four," the sacred formula of the common sense, realized in reality itself. This does not hinder it to be approximately correct in a great number of cases, because the organizing and disorganizing processess continually intermingle in our experience, but only *approximately.* It is quite precise only in the limiting, ideal combination; the more perfect are the modes of investigation, the more departures from it are inescapably revealed; and with a sufficient precision of analysis none of the cases would turn out to conform strictly to it. For example, we are accustomed to think that the weight of a sack of potatoes coincides absolutely with the sum of the weights of the potatoes and the sack; but in the contemporary teaching about electrical mass, as the basis of matter, the equality here also depends on the coarseness of our methods; mass depends on the mutual disposition and relative motion of those electrical elements from which atoms are composed; and weight, besides this, depends on unequal distances among individual parts of the entire complex, the center of the earth and the centres of gravity of other surrounding masses.

It goes without saying that two men and two other men always constitute exactly four men. But then the fundamental imprecision and conditionality are contained in that actually different and unequal complexes— individual people— are taken as ideally equal mathematical units; that is, in the designation itself all inequalities and differences are removed beforehand. The arbitrariness of this mode of thinking becomes obvious at once, if we ask the question: are two women and two unicellular human embryos, just beginning to develop inside their organisms, actually four people?

Theory is the servant of practice and calculation exists for practical computations. And although, for example, individuals who are selected as army recruits are comparatively homogeneous in strength and endurance, their number is quite an inadequate datum in itself for military calculations or even approximations. Experience gained from the French colonial wars in North Africa has shown that with equal armaments the average Arab soldier in a one-to-one encounter is no worse than the average French soldier; but a detachment of 200 French soldiers is already stronger than an Arab detachment of 300-400 men; and a force of 10 thousand Frenchmen is able to demolish the army of natives numbering 30-40 thousand men. European tactics give a much more perfect summation of military forces, and mathematical calculation is in fact refuted. But as the first approximation for a practical calculation, it is certainly useful and indispensable.

In other cases this first approximation is sometimes quite sufficient for the needs of everyday life, or even generally quite precise. In all cases where it can be established and applied its practical organizational role is enormous. Such is the vital meaning of mathematics: without it scientific technology, all modern systems of production and market, and the planned conduct of modern wars are impossible.

It is easy to note that there is a special correlation and a deep kinship between mathematics and tektology. The laws of mathematics do not refer to this or that *field* of the phenomena of nature, as laws of other special sciences do, but to *all* and *any* phenomenon, and only from the point of view of their magnitudes; it is, in its own way, as universal as tektology.

For the consciousness brought up on specialization, the strongest objection against a possiblility of the universal organizational science is precisely its universality: is it really possible that the same laws can be applied to combinations of cosmic worlds and biological cells, living people and etheric waves, scientific ideas and energy atoms? Mathematics provides a decisive and indisputable answer: yes, it is quite possible because it is so in fact; two plus two homogeneous separate elements constitute four such elements, whether they are astronomical systems or images of consciousness, electrons or workers; for numerical schemes all these elements are indifferent and there is no place here for any specificity.

At the same time mathematics is not tektology; the notion of organization itself is not encountered in it. If so, what then is mathematics?

It is defined as the "science of magnitudes." A magnitude, however, is the result of measurement, but measurement denotes successive application to the object being measured of a yardstick, and, obviously, originates in the assumption that *the whole is equal to the sum of its parts.* To measure a phenomenon or to consider it as a magnitude, that is, mathematically, means precisely to take it as a whole which is equal to the sum of parts; in other words, as a *neutral complex.* And we have established that a neutral complex is one in which organizing and disorganizing processes are mutually balanced.

Thus mathematics is simply the *tektology of neutral complexes,* developed before other parts of the universal organizational science. It has managed until now without notions of organization and disorganization, because it has as its starting point combinations in which both are mutually destroyed or, more correctly, paralyzed.

Two departments are distinguished in all natural sciences: "statics," or the teaching about forms of equilibrium; and "dynamics," or the investigation of the same forms in their motion and changes. For example, the anatomy and histology of the organism are its statics, and physiology its dynamics. Statics had evolved everywhere before dynamics, and was later transformed under the influence of dynamics. There is, as we can see, an analogous relationship between mathematics and tektology: one expresses the organizationally static point of view, the other the organizationally dynamic. This second point of view is the more general of the two: equilibrium is always only a special case of motion, and besides, in essence, only an ideal case, the result of fully equal and fully opposite changes in direction.

Of course, mathematics also investigates changes in magnitudes, but it does not touch upon the organizational form of those processes to which they relate: this form is assumed to be static and unchanging; the result of any such change, such as a new magnitude, remains a neutral complex as before and is equal to the simple sum of its parts. In mathematical analysis are also included those cases where magnitudes mutually destroy each other, completely or in part; that is, they are combined in the sense of disorganization as positive and negative magnitudes or as "vectors;" but this mutual disorganization of magnitudes, however, leads to new magnitudes, from one set of neutral complexes to another.[1] Consequently, mathematical dynamics is not organizational dynamics; it does not relate to the transformation of organized forms.

Thus, for tektology, the first basic notions are those about elements and their combinations. Elements are activities and resistances of all possible kinds. Combinations result in three types: organized, disorganized and neutral complexes. They differ in the magnitudes of the practical sum of their elements.

2. Paths and Methods of Investigation

i. The Organizational Point of View

The organizational science is characterized first and most of all by its *point of view.* All the peculiarities of its problems, methods and results flow from this. The difference from other contemporary sciences arises already with the *statement of the question.*

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[1]Positive and negative magnitudes are symbols of motions directed *straight in opposite directions*; vectors are symbols of motions directed *in different directions*, as, for example, the sides of a triangle. Following one, then the other side of a triangle, we come to the same point, where will bring us also the third side; this is depicted in the summation of vectors in such a way that the sum of the two sides of a triangle is equal to the third side, although numerically, of course, the third side is always lesser than the sum of the other two. The theory of vectors and the theory of quaternions evolving from it provide enormous simplifications in problems concerning space, forces, velocity, etc.

Here it is necessary to establish two essential moments:

(1) any scientific question can be posited and solved from the organizational point of view, which special sciences either fail to do or do unsystematically, semi-consciously or in the form of exception only.

(2) the organizational point of view also raises new scientific questions, which the contemporary special sciences are unable to contemplate, define, or solve.

It would seem that the organizational point of view should be closest to the biological and social sciences, which study organisms and organizations. However, even there it is far from being realized; it is only partially and unsystematically applied. Therefore, in many cases it is sufficient to apply it decidedly and clearly to this or that problem, in order to immediately obtain a new insight into all previously known facts, and later to gain new conclusions, sometimes deeply different from the previous determinations.

For example, the entire enormous question concerning ideologies, (i.e., forms of speech, thought, laws, ethics, etc.), a question embracing a broad field of social sciences, is usually considered apart from the notion of social organization as a whole, the parts of which are joined by indispensable and vital connections. Marx was the first to explain this connection definitely, but not fully; he partly explained only one of its features; that is, the dependence of ideology on the relationships of production, as secondary forms, or forms derived from the basic forms. He left the objective role of ideology in society and its indispensable social function unexplained. In an organized system each part or feature complements other parts or features, and in this sense is a necessary element of the whole in which it performs a special function. In individual cases, Marxism approached this problem by establishing that this or that ideology serves the interests of this or that class, strengthening the conditions for its supremacy, or that it is an instrument in the struggle with other classes. But Marx did not posit the question in a general form, and for many important cases uncritically took the old, prescientific formulations; for example, he considered art to be a simple adornment of life; mathematical and natural sciences as non-class; the highest scientific truths as pure and independent of social realtions. The organizational point of view changed these concepts at once, removed diversity and vagueness from them, and pointed to the real and indispensable place of ideology in the life of society. Ideologies are organizing forms for the entire practice of society or, what is the same thing, its organizational instruments.

Indeed, they are determined in their evolution by the conditions and relations of production, but not only as their superstructure; they also organize a certain content, are determined by it and adapted to it. The entire ideological side of life appears in a new light, and the whole series of its riddles is explained comparatively easily.[1]

A special illustration from the same field is the question concerning the origin of animism, i.e., the division of man and other living beings, and originally of all objects of nature, into "soul" and "body." Previous theories of animism did not even touch the fact that the relation between "soul" and "body" has a clear social organizational character; namely, it corresponds to that form of cooperation which I called "authoritarian:" the relation of an actively commanding element and the passively submissive element, or the leading and the executing element. Meanwhile, as soon as this aspect is introduced into the investigation, a new way is outlined to the solution of the problem. Animism turns out to be a transfer of the organizational form of the labour relations of people into thought. Moreover, there is an opportunity to explain fully all the historical fortunes of animism: why it did not exist, as it is now acknowledged, during the first phases of life of mankind before the development of authoritarian cooperation, why it was intensified during some epochs of history, weakened in others, following the rise or decline of this or that social form, etc.[2]

In political economy many important questions are resolved incorrectly or remain unsolved, because of the inability of specialists to adopt the organizational point of view. A vivid example is the theory concerning the laws of exchange. The notion of "marginal utility," which rules over the old official science, originates from principles which can be frankly called "anti-organizational." It takes as its basis the subjective relationship of a separate man to his individual needs; the individual psychics with its fluctuating valuations of useful things. Meanwhile, the exchange of goods is an expression of the organizational relations among people in a society; it is a system of production; and the activity of separate psychics with its subjective valuations reduces to an adjustment of a given individual with his

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[1]Systematic review of ideologies and their evolution which form this point of view are given in my work, "The Science about Social Consciousness" (2nd ed., 1919). Review of materialistic and cognitive philosophical teachings— "Philosophy of the Living Experience." Concerning class art and class science— "Art and the Working Class," "Socialism of Science" (both books, 1918).

[2]This theory of animism was first outlined by me in the 2nd edition of "Short Course of Economic Science" (1899). There are no substantive objections to it to this day.

economy to the objective, independent conditions of social organization. But none of the subjective valuations can change even that price of merchandise for the individual which he finds at a given moment in the market, not to speak of the technical conditions of production of the merchandise, which constitute one of the most permanent moments in the determination of prices.

The theory of labour value, on the contrary, originates from the concept of the social organization of production and in this sense stands on the organizational point of view. But to this day it is also not quite completely carried out; meanwhile, a complete and formal proof of its correctness is achieved only with further steps along the organizational route. It consists of an investigation of the conditions of mutual exchange under which enterprises are able to maintain and increase their share of work in the general system of production. It turns out that this is achieved precisely by an exchange on the basis of labour norms, with strictly defined and indirectly dependent departures.[1]

The question concerning the origin of sleep can serve as an illustration from the field of biology. There are a number of theories which attempt to explain directly the conditions of alteration between sleep and vigilance in the organism. It is very likely that a number of them will turn out to be partially correct. The organizational point of view, in different degrees, is part of their nature as it is, generally, also a part of all serious physiological theories. In particular, this concerns the theory of M. Duval, which explains the phenomenon of sleep as an amoeba-like movement of the brain cells: their appendices shorten and interrupt the connections between the nerve centers, thus causing an absence of consciousness and all the other symptoms of sleep. The same can be said about the views of Klapard, according to which sleep is a defensive function of the organism, protecting it from exhaustion. But even these broad concepts do not contain the one essential feature of the holistically organizational point of view: they do not contain the notion concerning the relationship of the organized system to its changing environment. And as soon as this feature is taken into account, something new immediately emerges: the connection of sleep with the astronomical cycle of days and nights among a great majority of living beings, and, among those subjected to winter hibernation, with the cycle of time in the year.

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1 In general, such a proof was at first given by me in an article "Exchange and Technology" in the collection, "An Outline of Realistic World View" (1st ed. 1903, 2nd ed. 1905). Similarly and more precisely it is developed in 4th ed., II volume "Political Economy," A. Bogdanov and I. Stepanov (First chapters).

Both daily and yearly cycles denote deep periodic changes in the general conditions of life on the earth's surface. The light of the full moon is six hundred thousand times weaker than the sunlight; and the sight of a majority of animals, especially of higher animals, is the main means of orientation with respect to resistances, opportunities and dangers in the environment. There are also changes in temperature, humidity and other atmospheric conditions. The totality of external conditions for each organism is quite different: a being which is fit for daylight activities is quite likely to be unsuited to night activities, and vice versa; complete dual suitability may be encountered only as a rare exception. Hence also arises the distinction in the biological situation as a whole between the night and the day life of animals and plants, which intensifies even further the unsuitability of each separate organism either to day or night conditions in the struggle for existence.

If, for example, the organization of man evolved in a sufficiently precise correspondence to the day conditions, then it could not be fit to the same degree for night activities. Thus, though his eyes contain a special mechanism for night sight, man sees much worse at night than during the day. A deep trace of primitive man's helplessness during night is preserved in the form of an instinctive fear of the dark in our children, usually taking the form of an elemental, convulsive, "mystical" fear. Many night animals are similarly helpless during the day; you only have to look at an owl or an eagle-owl by daylight to see this.

It is necessary for the organism to have, as fully as possible, isolation from this undesirable, periodically appearing situation; obviously, also a periodic isolation. Such is the role of sleep. Immobility reduces contact with the environment to a minimum; the interruption of impressions removes events of the external world from motor reactions, with all their consequences. Hence, the astronomic frame for periods of sleep: day, night and winter. Transmigrating birds achieve isolation from winter conditions by an immense air passage; the bear cannot do this and therefore hibernates. Man achieves the same by heating his den; in nature, the same purpose is achieved in a variety of ways. Thanks to artificial light, man can partly deviate from the twenty-four-hour cycle; in general, he sleeps less than the majority of animals. However, in tropical countries the twenty-four-hour cycle contains one more period of hibernation for him as for many other animals— after midday, the time of inactivity due to intense heat.

This generally organizational confrontation of the "organism and its environment" permits us, in principle, to solve the question concerning the origin of sleep; the study, however, of the mechanism of sleep still remains to be done, but the governing idea is there.

In practice, the organizational point of view has been most fully implemented in sciences which do not use the term "organization"— namely in the physio-chemical sciences. Only it is denoted differently there; namely, as a "mechanical" point of view. It investigates any system both from the point of view of the internal relationships among all of its parts and also the relationship between it as a whole and its environment; i.e., all external systems. As was already explained, "mechanisms" are, firstly, those organized systems which are systematically built by people themselves, and then all those systems whose structure has been learnt to the same degree as, for example, in the case of technical systems created by man.

However, in the physio-chemical sciences, a fully conscious and therefore completely consistent application of the organizational idea can also lead to statements of new questions. Thus, for example, enormous interest is aroused by the controversy about the "principle of relativity in contemporary physics;" its formulation and investigation are entirely based on the correlation between observers capturing given events, and on conditions of signalling which permit the coordination of their observations. It is clear that in organizational sense the concept of the physical environment is widened here; into it are brought elements which were not taken into account before; namely, investigating beings and their interrelationships.[1]

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[1] I will note that the present formulations of the principle of relativity by Einstein and others appear to me from the organizational point of view to be imperfect. They take into account only two observers and the light signalling between them. Since a direct signalling is impossible when observers move away from each other faster than the speed of light— the ray of the signal from one cannot then catch up with the other— it is assumed that relative speed of bodies is always less than the speed of light; and the latter is already the *absolute* limit of speeds. Meanwhile, as soon as a third observer is introduced into the system, as an intermediary between the other two, we have something different. With the decomposition of radioactive bodies some beta-particles, i.e., electrons rush with a speed close to the speed of light, for example, 285 thousand kilometers per second (light – 300 thousand kls). For the observer located in the middle between two such particles rushing in opposite direction, it should be quite clear that they move away from each other with the speed of 570 thousand kls, i.e., faster than the speed of light. If we assume the existence of observers on each of them, direct signalling between them is, obviously, unthinkable; but with the help of the first, located between them, they can enter into communication and establish their interrelations, including knowledge that they move away from each other faster than the speed of light.

In general, it should be obvious that the organizational point of view is capable of yielding new results and leading to new statements of the most diverse questions of cognition from those which have been posited hitherto.

ii. The Universal Statement of Questions

The organizational point of view also raises questions which could not be posited by specialized sciences, but which must nevertheless be acknowledged as perfectly scientific questions. These are the questions which relate to the unity of organizational methods in nature, practice and cognition.

There are, for example, the following scientific facts. The eyes of the cuttlefish or the octopus present the greatest resemblance in structure to the eyes of higher vertebrata, such as man. Both are structures of gigantic complexity, with hundreds of millions of elements which are highly differentiated and harmoniously connected with each other. However, it can be undoubtedly assumed that both evolved completely independently, from two far-removed branches of the geneological tree of life; the common ancestors of man and the octopus could not have had eyes in our sense of the word; at best, they had pigmented specks for a reinforced absorption of rays in the exterior layer of the body. Independence in origin is especially emphasized by the circumstance that the layers of the retina receiving light are arranged in a reverse order in the higher mollusks to the arrangement of similar layers in the higher vertebrata. This is one of the most miraculous coincidences in nature.

Can biology, as a special science, posit and solve the question of such a coincidence, and a coincidence to such a degree? There is a general proposition that like functions lead to the evolution of like organs. But the notion of "analogy" says nothing about the possibility of such a striking coincidence; for example, the corneous external skin of man, the chitinous membrane of insects and the limy shell of mollusks, etc., are "analogous." Biology can trace two lines of historical evolution and a series of transitions which have led independently from the simple accumulation of pigment to architecturally indentical optical structures, a million times more complex than our microscopes and telescopes. But the very separateness of both lines excludes the possibility of an answer which would give reasons for the coincidence of their final results.

Biology, in fact, did not posit the question in this form, althought more than sixty years have elapsed since the investigations by Babokhin of the eyes of cephalopoda. But from the organizational point of view, the question still remains. This is a special case of the general question concerning the unity of organizational methods in nature. And its scientific solution must be achieved on the basis of analyses and generalizations of organizational experience.

In the physio-chemical sciences there exists the "law of equilibrium," formulated by Le Chatelier. This law states that systems which are in a state of equilibrium tend to preserve it by producing internal opposition to forces changing it. Take, for example, a vessel containing water and ice in equilibrium at 0° C under normal atmospheric pressure. If the vessel is heated, then part of the ice will melt, absorbing heat and thus continuing to maintain the former temperature of the mixture. If the external pressure is raised, then part of the ice will again be converted into water which occupies a smaller volume, thus weakening the rise in pressure. In contrast to water, other liquids decrease in volume with freezing. With the rise in pressure and under the sameconditions of mixture, they exhibit an opposite change: a part of the liquid freezes; the pressure is obviously thereby weakened as in the previous case. The principle of Le Chatelier is applied at every step to solutions, chemical reactions, and motions of bodies, thereby permitting the prediction of changes in the most varied cases.

But the same law, as has been shown by many observations, is also applicable to biological, psychic and social systems which are found to be in equilibrium. For example, the human body reacts to external cooling by intensifying internal oxidizing and other processes which produce its heat; with overheating the heat is removed by the processes of evaporation. Normal psychics, when it is deprived of external sensations, such as when a man finds himself in a prison, compensates for this lack by intensifying the activity of fantasy and by developing attention with respect to trifles; on the contrary, with an overload of sensations the attention to particulars is lowered, and the action of fantasy is thereby weakened, etc.

It is clear that the question concerning the universality of the law of Le Chatelier cannot be posited and systematically investigated by any of the special sciences—the physio-chemical sciences have no business with psychic systems, biology with inorganic,or psychology with material systems. But from the organizational point of view, the question is obviously not only fully possible but inescapable.

Such questions are usually called "philosophical." Two ideas are hidden in this label. The first is that such questions are beyond the scope of specialized sciences; this is quite correct. The second is that such questions do not have a strictly scientific character and are not completely investigated by scientific methods, but by some "philosophical" methods. This must be refuted.

iii. Methods of the Organizational Science

Thus, the organizational point of view if applied consciously and holistically leads, on the one hand, to a change in the statement of questions by special sciences, and on the other, to new scientific questions which go beyond the limits of these sciences. What methods should be used in investigating such questions?

Generally scientific methods should be used which were predominantly worked out in the natural sciences. They are essentially the same for all sciences and vary only in the particulars of application. The psychological and social sciences are, so far, backward and imprecise; but as they develop, their methods will more closely approach those of the natural sciences. Therefore, without predetermining future developments, it should be accepted that the organizational science must begin with these general methods and strive to apply them as strictly and precisely as possible to the problem at hand.

Induction, leading from particular facts to increasingly broader generalizations and eventually to universal ones, is represented by three basic forms: *generalizing-descriptive, statistical and abstractly analytical.* All of them are obviously applicable to the phenomena of organization and disorganization.

As far as generalizing descriptions are concerned, it may be noted beforehand that they should be distinguished in the organizational science by a tendency to "abstractness," to an even greater degree than the generalizations in specialized sciences. The description of organizational facts aims to embrace the relationships of all kinds of elements; and this means it must abstract itself from those elements; however, the description of facts given by specialized sciences always has in mind various definite elements from which it cannot abstract itself. For example, even physical chemistry, one of the broadest of these sciences, investigates correlations of "bodies" or "physical things;" its descriptions are always concerned with characterizations of "bodies" or "things," and their connections and combinations. Tektology, however, constantly aims to transcend these limits; and a generalization is completed in this sense only when it expresses equally well the connections or combinations of bodies, representations, ideas, etc. For tektology, as for mathematics, all phenomena are equal and all elements indifferent. The few generalizations of experience from which mathematics departs are not only universally general, but also maximally abstract. The tektology of organized and disorganized complexes must obviously work out many more generalizations than the "tektology of neutral complexes," i.e., mathematics, but nevertheless generalizations of the same type. The path to their development is longer and more complex, inevitably presenting a series of stages at which generalizations are tied to various elements, as they are in the specialized sciences; the difference lies in there being posited in advance an aim to remove this restriction and find formulations which would be suitable to any other element.

Statistical methods include, as is well known, a quantitative enumeration of facts and a calculation of their recurrence. Quantitative calculation is clearly assumed in the very determination of "organization" and "disorganization:" only when it is made, can it be stated whether or not in fact the whole is practically greater or smaller, in some definite aspect, than the sum of its parts and by how much. It can be assumed, however, that the calculation of the frequency of various combinations must play a part, but primarily at the lower stages of investigation, before it has gone beyond the limits of a group of special, concrete facts. It would be strange and hardly expedient to calculate the frequency, for example, of the centralist forms of organization in the structure of inorganic systems, living beings and psychic complexes, social and ideological groupings, etc. By the way, approximate estimates, in the sense of a particular frequency or rarity of various combinations, may play an important role even here.

Higher stages of investigation are achieved by the abstract analytical method. It establishes the *basic laws* of phenomena which express their invariable tendencies. "Abstraction," that is, the separation or removal of complicating moments, serves as a means for this; it reveals the basis of any given phenomenon in a pure form; namely, that invariable tendency which is hidden under the visible complexity. Sometimes, abstraction is carried out in real terms, as in the case of precise "experiments" in the natural sciences; sometimes, however, ideally or mentally, as in the case of the majority of abstractions in the social sciences. For example, when physicists were investigating the conversion of mechanical motion into heat, they endeavoured with the aid of special apparatus to eliminate any losses of the generated heat in excess of the limits of precise control and any accidental inflow of heat from outside; or, what is the same thing, they aimed to establish a full equilibrium of such losses and inflows. In this way they recreated the phenomenon in a "pure form;" that is, they practicably simplified it, freeing it from complicating moments and making its basis accessible to observation—in the scientific, and not in a metaphysical sense, of course,—and found its law: a definite quantity of mechanical motion is converted into a definite quantity of heat which is strictly proportional to it.

In the same way chemists searching for the law concerning the connection between substances endeavour to get the investigated substances into a pure form by "abstracting" from them any admixtures by various processes of decomposition or "analysis;" and later, inducing reactions between the "abstracted" substances, the chemists systematically remove or neutralize all the collateral, observing phenomena, such moments as, for example, the departure of gaseous products from the field of observation, etc. This example from chemistry makes particularly clear why the abstract method is also called "analytical:" its essence lies in the decomposition and analysis of complex objects and complex conditions, and in working with simplified objects and simplified conditions which emerge as a result of analysis.

It is easy to see that astronomers are in a different situation from that of physicists or chemists. When observing a tangled motion of some planet or comet in the heavenly firmament, they are deprived of a possibility to analyze practically this motion, to simplify it in reality, to remove such complicating conditions as, let us say, the motion of the Earth itself with its observations, its perturbations resulting from the pull of various other cosmic bodies, and the uneven fracture of rays in the atmosphere, etc. At the same time, abstraction and precise investigation, without simplification, is not possible here: it is not carried out in a real experiment, but mentally. One after another, the attendant moments are eliminated from estimates and calculations, until there remains the structure of an investigated orbit of the planet or a comet in relation to the centre of the system, usually the Sun. The very beginning of the new astronomy lies in the powerful effort of the abstract thought of Nicholaus Copernicus, who found the principal complicating moment of the visible motion of planets in the motion of the Earth itself and succeeded in "abstracting" it by mentally placing an observer on the Sun. This was the first step in astronomical abstractions; later, it was easier to find and remove by analysis other observed astronomical facts.

In the social sciences, with the colossal complexity of their subject matter, a real simplifying experiment is so far only possible in exceptional cases. Therefore, here too the decisive role belongs to mental abstraction, the first models of which were given by bourgeois classical economics and later, in a more perfect and valid form, by the investigations of Marx.[1]

In what form should the organizational science apply the abstract method? The answer is provided by facts. The point is that although this science does not yet formally exist, *organizational experiments* do exist.

The experiments of Quincke and particularly those of Buchli with "artificial cells" are well-known. They involved the formation of colloidal mixtures which approached living protoplasms in their physical structure. In these mixtures it was possible to recreate the principal motor reactions of unicellular organisms: movement by means of released "false feet," similar to those of the amoeba; the embracing and enveloping of hard particles, copulation, etc. To what field of science should these experiments be referred? To biology? But its subject matter is living bodies and living phenomena, which are absent here. To the physics of colloidal bodies? The entire aim and meaning of the experiments lie outside its problems; the question concerns a new illumination, a new explanation of the processes of *life.* It is clear that these experiments belong to that science whose problems and content embrace both at the same time: the science about the general structure of both the living and the dead in nature, about the base of organization of all forms. Thus, we have an experiment in which what we are accustomed to think of as "life" is "abstracted" from the living function; everything particular in it is abstracted, so that there remains only its general structure and the basis of its organization.

Plato's ancient experiment reproduces a picture of the rings of Saturn by means of the rotation of a liquid sphere in its balanced environment (composed of another liquid of the same specific gravity). Again, to which scientific field does this experiment belong?

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[1] More basic and in part more detailed explanations of the three phases of inductive method are given in the "Political Economy," A. Bogdanov and I. Stepanov, vol. 1, pp. 5-11 (2nd ed.) and in "The Science about Social Conscience," A. Bogdanov, pp. 10-21 (2nd ed.).

Neither hydrodynamics nor cosmology can rightfully claim this experiment which relates to questions concerned with the basic architecture of the universe. It essentially and fully belongs to the organizational science.

The same can be said of the experiments of Mayers, which explain a possible equilibrium of electrons in the atom by means of an electromagnet and tiny floating magnets or currents.

The main feature of the application of the abstract method in tektology can be seen in these illustrations. In the experiments, for example, of Buchli, or of those following the same path, such as Rumbler, Herer, Leduc and Leman, the "biological" material is first abstracted from the living phenomenon; later, it is also necessary to abstract *mentally* from the material which has served as a basis for the experiment. Real abstraction is indispensably complemented with mental abstraction.

Of course, tektology will be forced even more often to limit itself to mental abstraction.

Such are the inductive paths on which the organizational science must work out its generalizations and laws. Next, begins the role of deduction which adds and combines the results so obtained in order to get new theoretical as well as practical conclusions. It is possible to anticipate that this role will be enormous. In mathematics— the tektology of neutral combinations— it is so overwhelmingly great that it has for the majority of thinkers completely overshadowed the experimental or inductive basis of this science. In the tektology of organized and disorganized complexes such a basis must be much broader; a "neutral" connection, or equilibrium of organizing and disorganizing moments, is still an extraordinarily simplified special case which facilitates deduction to the utmost degree. In general tektology, consequently, the correlation of induction and deduction cannot be so uneven. As a universal science, it must in full measure and with the greatest harmony unite in itself the all-scientific methods.

3. The Relationship of Tektology to Particular Sciences and Philosophy

As has already been explained, questions of the specialized sciences can be posited from the organizational point of view, that is, "tektologically." This point of view is always broader and,therefore,capable, at least in some and perhaps in all cases, of leading to results which are fuller and more precise. The experience of all the sciences shows that the solution of particular questions is usually achieved only when they are preliminarily converted into generalized forms; and at the same time, together with the originally posited questions,many other similar questions are solved. Thus, if someone posited as his problem the explanation of the distance between the Earth and the Moon and constrained himself within these limits, he would have never come to anything; but the solution of a more general problem– how to find the distance from an object without approaching it–has immediately opened the road to the solution of the given particular problem, and of an unlimited number of others. The basic significance of tektology lies in the most general statement of questions.

Hence the relationship of tektology to particular sciences is easily established; it is ***unifying and controlling.*** Their entire material and all the results they have obtained lawfully belong to it, as a basis of its work; all of their generalizations and conclusions are subject to its verification from the point of precision and completeness, inasmuch as a relative narrowness of the specialized point of view may be reflected in both.

The methods of all sciences are for tektology only modes for the organization of material supplied by experience; tektology investigates them in this sense as it does any other possible methods of practice. Its own methods are not excluded: they are precisely the same object of investigation, organizing modes and no more. Tektology rejects as fruitless scholasticism the so-called "epistemology," or philosophical theory of cognition which aims to investigate conditions and modes of cognition not as vital, organizational processes among other processes, but abstractly, as a process which differs essentially from practice.

Tektology should not be confused with philosophy. Philosophy at its birth was simply an aggregate of scientific knowledge which was not yet separated into specialities, but was connected by naive general hypotheses. In the epoch of the specialization of sciences, it became a super-structure over scientific knowledge, expressing the striving of human thought toward unity. But it could not achieve this in fact, for it disintegrated itself according to the basic break of social life into theoretical and practical branches. Both differ fundamentally from tektology.

Practical philosophy has in mind general moral leadership in the behaviour of people. For tektology morals are only an object of investigation, as one organizing form among others; tektology considers the moral relationships among people from the same point of view as the relationships of cells in an organism, parts in a machine, electrons in an atom, etc. It is just as alien to morals as is mathematics.

Theoretical philosophy strived to *discover* a unity of experience in the form of some universal *explanation.* It wanted to paint a harmonious and intelligible *picture* of the world. Its tendency is contemplation. For tektology the unity of experience is not "discovered," but activity *created* by organizational means: "philosophers wanted to explain the world, but the main point is to change it" said the greater precursor of organizational science, Karl Marx.[1] The explanation of organizational forms and methods by tektology is directed not to a contemplation of their unity, but to a *practical mastery* over them.

Philosophical ideas differ from scientific ideas in that they are not subject to empirical verification; for example, a "philosophical experiment" is a completely unnatural combination of ideas. The constant practical verification of its conclusions is obligatory for tektology; organizational laws are necessary first of all in order to apply them; and tektological experiments are not only possible, but, as we have seen, already exist. The fundamental difference between philosophy and tektology is especially clear here.

Philosophy has frequently anticipated broad scientific generalizations in its unifying work; the most striking example is the idea about the indestructability of matter and energy. In this sense, philosophy is also a precursor of tektology. Such philosophical conceptions as dialectic or the teaching of Spencer about evolution have a hidden and unconscious but indisputable tektological character. Inasmuch as they will be investigated, verified and organizationally explained, they will enter into the new science, and, at the same time, lose their philosophical character. In general, tektology, with its development, should make philosophy superflous, and from the start it is already superior to it since it combines with its universality a scientific and practical character. Philosophical ideas and schemes are for tektology objects of investigation as are any other organizational forms of experience.

Tektology is a universal natural science. It is just being conceived; but since the entire organizational experience of mankind belongs to it, its development should be swift and revolutionary, as it is revolutionary in its nature.

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[1] One of his 11 theses on Feuerbach.

III

Basic Organizational Mechanisms

1. The Formulating Mechanism

i. Conjunction

Man in his organizational activity is only a student and imitator of the great universal organizer, nature. Therefore, human methods cannot transcend the methods of nature, and represent in relation to them special cases only. But for us, these special cases are, of course, better known and, therefore, the study of organizational methods should begin with them and then go on to the more general, and ultimately, the universal means of organization in nature.

It was long ago noticed and established that man in his activity, practice and cognition only joins and separates some given elements on hand. The process of labour reduces to the joining of various "materials" and "instruments" of labour with the "labour force," and the separation of various parts of these complexes, which produce as a result the organized whole, a "product."

The efforts of the worker, the cutting instrument, and a piece of wood are joined, shavings and bits of wood are cut off, and the instrument is separated from the wood, completing its movements; a new force is applied to the instrument, which brings it into a new contact with the wood, etc.: the chain of combinations and disjunctions is sometimes comparatively simple, frequently very complex and hard to describe in words; but there is always only this and never anything else that could not be encompassed in these notions. Similarly, in the field of cognition. The generalizing effort binds and unifies elements or complexes of experience; the discerning effort separates them; nothing else, going beyond these limits, can exist here. No logic or methodology was able to this day to find anything else.

But further investigation reveals that these two acts, joining and separation, do not play an equal part in the activity of man or occupy in it an equal place: one of them is primary, the other a derivative; the one can be direct, the other is always only a result. Assume that a worker must cut a piece of wood into two parts or even break it; he must, generally, divide it in this way or that. No straight or direct act which would accomplish this is known to exist: the worker must invariably bring the object being separated into contact either with the instrument or with organs of his body— the act of joining— and he must apply to this system a definite effort, which is another act of joining. The breach of connections in the object occurs only as a *consequence* of these combinations and as an event of a *secondary* character.

The process is no different in cognition. No "distinction," "opposition" or "differentiation" is possible without a preliminary *comparison*; that is, without the joining of separated complexes in some common field, the field of "consciousness" or "experience." The child does not know for a long time how to distinguish a cat from a dog, or one strange man from another; only when he happens to see them both side by side, or when their images become so customary and firmly implanted in his consciousness that he can compare a clear representation of the absent man with a perception of the man present, can he "distinguish" between them, i.e., separate them in his experience. The very effort which is directed to such a purpose appears only if two complexes have something in common, have some of their elements merged, or are blended when encountered in the field of experience. Consequently, separation is also secondary here; it is a derivative that occurs on the basis of a union.

Passing now to the processes of elemental nature, we find in them the same two moments and correlation. It is possible to conceive any event, any change of complexes and their forms, as a chain of two acts: the act of joining what was separated, and the act of separating what was bound together. For example, the nourishment of an organism constitutes a connection of environmental elements to its structure; propagation occurs through separation from it of a certain group of its elements; all chemical reactions reduce to combinations of atomic complexes or their decomposition; even the simple "displacement" of bodies should be understood as their detachment from one set of complexes of the environment with which they were spatially bound and an entry into a similar connection with others. At the same time, one can establish as an indispensable, preceding moment, some act of a connecting character for any breach of connections. For example, a free cell usually propagates through division on the basis of its growth, i.e., the joining of substances from outside; the propagation of a chemical complex takes place as a result of either a contact with another substance or an entry into it of new activities from outside, such as thermal and electrical activities. A completely independent act of separation which is not induced by some act of joining cannot exist.

Consequently, the primary moment begetting changes, emergence, destruction and the development of organizational forms, or *the base of the formulating tektological mechanism*, is the joining of complexes. We will denote it by the term *conjunction*[1] taken from biology, which is deeper in meaning and universal in application.

It is necessary to perceive distinctly the universality of this concept in order to operate with it tektologically. Conjunction is cooperation or any other social contact, such as speech and the connection of concepts into ideas, the meeting of images and aspirations in the field of consciousness, the fusion of metals, the electrical discharge between two bodies, an exchange of goods between enterprises, and an exchange of ray energy between heavenly bodies. Conjunction binds our mind with the most distant planets which we see in the telescope, and with the smallest bacteria which we see in the microscope. Conjunction is the assimilation of nourishment which sustains an organism and of poison which destroys it, soft embraces of lovers and mad embraces of enemies, congress of workers of the same trade and a close fight of antagonistic detachments...

Scientific organizational concepts are as strictly formal as the mathematical concepts which properly belong to them; "conjunction" is like the addition of magnitudes, which is its special case. We consider fighting armies as two conjunctive complexes with the same justification as when we determine the total number of participants in a battle by adding numbers of both sides. The subjective goals of participants do not matter here; what is important are objective correlations: two complexes are in an "interaction,"

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[1]In biology this word is applied to the act of joining two free y existing cells constituting a prototype embryo of sexual propagation. With proper "conjunction," two cells unite temporarily and partly (they usually exchange a quarter of their nuclear composition); with so-called "copulation" they merge completely. In both cases, this is usually followed by the process of cell division; and each newly created cell has now a combined property inherited from both sides, thanks to which propagation turns out to be the creation of really new forms and not simply an augmented repetition of old forms. Exactly this nuance— a hidden indication at creation— makes the term "conjunction," in its universally-broadened sense, the most appropriate for tektology: from its point of view any creation of new forms is based on joining of independent complexes and each such joining leads to the creation of new forms.

the elements-activities intermingle, "influence" each other, generally "combine" with each other, cross from one complex to another in the form of taking prisoners and supplies, and also in the form of the mutual borrowing of experience, adopting from each other even such things as modes of struggle and, frequently, also practical information. The unity of communes, tribes and nations into extensive societies was historically achieved both through war and peace and friendly exchange; the difference lies in the quantity of expended energy, the degree of attendant disorganization; but, as we shall see, disorganization exists in all conjunctive processes, whether they have a "peaceful" or an "antagonistic" tendency. And the very results are far from being predetermined by this tendency; frequently,they do not even correspond to it; for example, the knife and energy of a surgeon, conjugating with vital complexes of his patient, may sometimes disorganize him to a much greater extent than the knife and energy of a felonious murderer; friendly communication may strike a man with a mortal blow; and malicious violence often brings about the most positive changes in life.

Thus, the results of conjunction are sometimes tektologically different. While investigating them in a general form, in relation to the elements-activities, it is easy to trace three conceivable cases.

1) Activities of one complex and the activity of another join so that they do not become "resistances" for each other; consequently, they join without any "losses." This is the limiting positive result. The most typical examples are: the merging of two waves of the same length with a complete coincidence of their crests and valleys; the merging of two drops of water into one, taken from the point of view of the chemical activities embodied in its molecules; the simultaneous and equally directed efforts of two workers applied under conditions of non-interference, for example, while lifting a log from both ends.

The more perfect the modes of scientific analysis become, the more decisively it is revealed that this represents, in its pure and finished form, an ideal case. In reality,there is no absolutely harmonious combination of activities under conjunction; combinations which would be characterized by complete absence of resistances on the part of some of their activities do not exist. Two waves do not coincide with absolute precision,and the direction of efforts of two workers is never fully identical: "losses" may be practically negligible and, therefore, rightly ignored or even inaccessible to contemporary methods of investigation, but for strictly scientific thought they always exist. "Matter" is the most stable form of activities known to man; but even here, the merging of two drops of water cannot avoid the destruction of even a few atoms, or, at least, the violation of their structure, during which a part of their electro-chemical energy is also "lost" and dissipated by vibrations. This does not prevent the assumption that in a great many problems of practice and theory such proximity to the limit is quite equivalent to its achievement.

2) The opposite case occurs when the activities of one complex become complete resistances to the activities of another and fully paralyze them or are paralyzed by them. Typical illustrations are the merging of waves of equal length and the same direction into half-waves; the contrarily directed efforts of two workers; the connection of charges of the internal and external covers of the Leyden jar, etc.

It seems at first sight that this case must be as ideal, but "only in the abstract," as the previous one. But this is not so. It is quite likely, perhaps even unquestionable, that the direction of the activities of two complexes will never be fully opposite; that their equal numbers cannot completely paralyze, or "neutralize" each other, that there are always, though negligibly small, active residues. For example, in the case of two persons pulling each other with equal efforts in opposite directions, some side and oscillating shifts are revealed without fail, thanks to the imprecise lines of these efforts; and even the mutual discharge of covers of the Leyden jar will never by itself lead to their absolutely neutral state; as a "suppressed oscillation" it can never end by itself. But an active residue in activities of one direction, in its turn, is fully neutralized if it meets the surplus of activities of an approximately opposite direction. In this sense complete neutralization is quite possible and represents a frequent phenomenon. The efforts of one worker can be completely paralyzed by the more considerable efforts of the other; a positive electrical charge by a more sizable negative charge, etc.

3) The most common case occurs when two complexes connect so that their elements-activities are partially added together and partially become mutual resistances, i.e., become organizationally subtracted. For example, two workers enter into a cooperation; both assist and also involuntarily hinder each other while combining their efforts more or less successfully at the same time; or two waves combine and partly intensify each other, etc. This or the other correlation dominates and determines the general nature of the resulting combination.

This case does not by itself need any explanation. But we should remember that a "complex" is a conditional magnitude, and that it depends entirely on the investigation on hand whether or not to subdivide it into parts which can be then considered as separate complexes. These parts can also be mentally singled out, so that for some of them there will be a full rather than partial neutralization of their activities. For example, in a number of the muscular efforts of two collaborators, it is possible to find that some of them are fully paralyzed by the unfavourably directed movements of the other worker. Consequently, the third case, with sufficient analysis, also contains as special moments the cases of the second type.

ii. Ingression

Now we are going to examine, in a general form, the results of conjunction from the point of view of the emerging systems. The process of conjunction is apparently accompanied by a certain degree of transformation of the complexes which have entered into it. It can result, as is clear from the foregoing, in the "destruction" or, more precisely, neutralization of one complex; or, if a number of them enter into conjunction, the neutralization of some of them. But besides this, transformation may be so deep that observation "cannot recognize" former complexes and, therefore, does not consider them to be the same: for example, conjunction of oxygen and hydrogen forming water, conjunction of two mechanical impulses producing motion as the resultant force, etc. However, the most general case is when we accept that complexes are "preserved;" even after a transformation they continue to exist, although in a changed form. Extreme cases, such as the destruction or radical reorganization of complexes, reduce to this general form with sufficient investigation: by tracing the elements of former complexes in new combinations, scientific thought reestablishes for itself those former complexes and finds under the changed forms their "indestructible" matter or energy, or those activities-resistances from which they were composed. If, for example, the positive and negative electrical charges of facings of the Leyden jar mutually neutralize each other by means of conjunction and discharge, then this does not mean that both of these activities have ceased to exist for cognition; the absence of their practical manifestations is explained by the fact that elements of both former complexes, grouped in pairs, paralyze each other; but they can be separated again and returned to a former combination by employing an appropriate influence from outside; that is, with the aid of a new conjunction with a third complex. Also, although oxygen and hydrogen are "not individually recognizable" after their combination into the form of water, chemistry cognitively continues to consider them in water molecules as their elements or atoms, and supplies ways to separate and regroup them into former systems. Consequently, from the scientific point of view, the result of conjunction is, in general, a system composed of the transformed conjugating complexes.

These complexes may either remain in mutual contact or separate again in the process of changes brought about by conjunction. The biological "conjunction" of living cells, bound with their propagation, relates exactly to the second type: two cells, having exchanged a part of their elements, separate again and independently divide further. The collision of two bodies, after which they continue their path in new directions and with new speeds, also belongs here. The process of separation can spread to the parts of the original complexes, as when two glass bodies break into pieces during a collision. Apart from this, separation sometimes generally proceeds on lines so far removed from the former separateness of complexes that it is not possible to say which of the resulting new complexes corresponds to this or that original complex; such, for example, are exchanging chemical reactions, such as the reaction of sodium (carbonic natron) with sulphuric acid which produces sulphuric natron, carbonic acid and water. But it is best to begin with a close consideration of the simplest and the most common cases, as when conjugating complexes remain in mutual contact without being radically disorganized: the union of animals of different sexes into a family, people into a union, links into a chain,and images of consciousness into an association, etc.

What is the connection which unites any given complexes? Considering all kinds of cases, it is easy to be convinced that its essence always reduces to the same thing: they have some part or a sum of elements in common. This is their *linkage.* It can be different in different cases. The linkage of two conjugating amoebas or bacteria is that merged part of their bodies which equally belongs to both; in the case of "copulation" it wholly embraces both bodies. The linkage of two links in a chain is that part of one link which lies inside the other; and especially the surface of their contact. The linkage of two associating images of consciousness is their "common feature;" the linkage of cooperatively organized efforts is their common object, etc.

All those changes which determine the organization and disorganization of the created system occur in the region of a linkage. In the case of conjugating living cells,it is exactly there that processes of exchange go on, raising their viability or, in cases of biologically unsuccessful combinations, lowering it. For collaborators, it is exactly in the common object that the application of their efforts occurs, either in the form of the merging of efforts into a harmonious combination which creates one powerful movement, or in the form of mutual hindrance which reduces their efforts to a practically small and sometimes an insignificant magnitude. In consonance and dissonance, the coinciding parts of sound waves form the field of harmonic and stable intensifying tones, or their disharmonic "beat," etc.

Linkage denotes the "entry" of elements of one complex into another, and vice versa; therefore, systems which are formed from complexes and bound by a linkage will be called *"ingressive"*(ingressio, means in Latin, "entry"). It is impossible to imagine any organizational combination which would not be based on ingression; this form is *universal.* Sometimes experience does not directly reveal the linkage between two complexes which nevertheless constitute a certain system and are bound by a mutual dependence; then cognition is forced to construct it and introduce it hypothetically. For example, if a magnetic arrow follows the motion of a piece of iron near it, then "magnetic forces" belonging simultaneously to both of them are assumed to emanate from one body to another, and vice versa; in the case of the sun and planets, a theory is created concerning some specific activities of "gravity" which,in the same way, serves as a linkage between them, etc. These constructions may turn out to be, of course, unsuccessful and incorrect; but then, the problem of cognition is not simply to reject them but to replace them with more expedient ones; cognition cannot manage without ingression for precisely the same reasons as practice cannot manage without it in those cases where it is necessary to organize a definite system from the complexes on hand.

Cognition in this case, as always, derives its methods from practice. Let us assume that it is necessary to connect firmly two pieces of metal, or wood, or a rope. Linkage is created by the entry of elements of one complex into another. To carry out such an entry directly is not always possible and, at times, impossible. In the case of ropes, this is, for example, easily achieved by weaving the fibres of both, or by tying their ends together. This simplicity and ease depend on the greater *relative mobility* of their parts. It is not so simple with two pieces of metal; their elements, under normal conditions, have very little mobility, and if the form of the pieces is not particularly suitable for welding, as in the case of a nut and bolt, this cannot be directly carried out. But technology knows methods of changing molecular mobility: the pieces of metal can either be completely melted down, thus permitting their fusion into one, or each of them can be melted on one side, thus permetting their welding directly or, finally, their mobility can be increased by heat below the molten stage to a degree that would permit "welding" with the aid of a strong mechanical influence. However, it is not possible to connect two pieces of wood in this way: they are irreversibly destroyed with heating before acquiring the requisite plasticity. In such cases, the method of *"introductory"* or *"instrumental"* complexes is usually applied. This role can be performed, for example, by glue, which in a liquid form easily attaches itself to the surface of the wood and then hardens, without destroying the acquired connection. Parallel to these methods, as if copied from them, are the cognitive methods of the unification of various complexes.

Wherever possible, cognition *directly* blends the common elements of given complexes; this is called "generalization." If, for example, in one field of thought, there are psychic images of water in a river, water in the stream, water in one or another vessel, etc., then the linkage between all of them occurs as if by means of superimposition of one image on another, thus creating unity in the form of a great number of coinciding elements. This is the basic, primitive phase of cognition. At a higher level, it first decomposes complexes into elements; that is, it mentally breaks down connections between them and thereby imparts to them a relative mobility. For example, the images of man, fish and insect are quite difficult to unite directly in the field of consciousness, and if they are superimposed on each other, the resulting combination is vague and easily destroyed. But, it must be noted, when biology at first practically decomposed these complexes into their integral parts, such as organs, tissues and cells, then it became fully possible to have such a comparison, i.e., mental conjunction, in which common elements are firmly united, thus bringing about a stable scientific ingression. Finally, in the solution of even more complex problems of conjunction, cognition resorts to the method of introductory or instrumental complexes.

For example, it introduces between man and the monkey an image of their common ancestor; between spatially removed but mutually dependent bodies, it introduces ether with various tensions and fluctuations in it, etc.

Man can create practical ingressions only in the field of his collective labouring muscular efforts; consequently, only in a limited framework. But this framework is being expanded with the progress of labour. Besides, experience shows that by means of one or many introductory links which are expediently chosen, it is possible to establish a real connection between any complexes, no matter how far they are removed in the field of labour, or how mutually incompatible in the direction of their activities. It is possible to coordinate the efforts of two workers who happen to be at the two opposite sides of the earth: it is only necessary to introduce between them a sufficient number of telegraphic stations and lines; it is possible to arrange a parley between fiercely fighting enemies: it is only necessary to find suitable intermediaries; it is possible to obtain a mutual understanding and precise coordination of actions between an Eskimo and a Papuan, between an English worker and a Russian peasant: to do this, knowledgeable and intelligent interpreters are necessary; it is possible to connect fire and water in the preparation of food, and tender cells of the brain centres and steel instruments, for production or destruction, etc.

Cognition operates with complexes which are much more plastic; and its field, which has as its base the same field of physical labour, expands much faster and easier. Therefore, it develops its chain of ingressions correspondingly faster and easier. By establishing ever new connections where they were previously absent and crossing in its unifying work any given boundaries in an increasingly shorter period of time, cognition has long ago arrived at the idea of a continuous connection of all that exists, at the idea of a "universal ingression."

iii. Disingression

The result of conjunction may happen to be not only more or less stable ingression. In many cases something else happens: the disintegration of the conjugated systems, the creation of new separate systems and new "boundaries." Let us consider one of the simplest events of this kind.

On a suspended silk thread hangs a small dumb-bell; this complex is known as the "physical pendulum." The thread is stretched out; the weight of the dumb-bell together with the insignificant weight of the thread represent a definite sum of activities directed at the centre of the earth. The dumb-bell, however, hangs up and does not fall down because there is another group of activities— the "coupling," which while counteracting the stretching more than paralyzes it and does not permit the dumb-bell to fall down.

Now let us conjugate a new complex with this system: hang on it another dumb-bell. The sum of stretching activities grows. If, however, it remains less than the sum of the coupling activities along the entire thread, the pendulum will continue to hang on as before. But let us assume another relationship: at one point, or more precisely, in one of the diametrical sections of the thread where the thread is, say, the thinnest, the sum of stretching activities is *precisely equal* to the coupling activities. What will happen then?

At first sight it seems that nothing exceptional should happen; both activities paralyze each other; consequently, neither of them manifests itself in real changes. But this is not so.

In the spot where the activities of a complex are fully neutralized, any resistance to the external activities also apparently disappears. And they always do exist. There are not and cannot be complexes which are completely isolated: each is surrounded by an *environment*, by other organized complexes and other activities. They are tektologically "antagonistic" to it: unfolding in their own ways, they can disturb its form and destroy it; they do not do this precisely because the complex represents a resistance. As soon, however, as at any of its points or regions the resistance disappears or becomes equal to zero, external activities enter there and the linkage of the complex is torn down. In the given case, this will be, for example, the molecular blows of the particles of the surrounding air. For a normal coupling of the thread which is in a state of rest, they represent an infinitely small magnitude; when the coupling is completely paralyzed, then infinitely small influences are sufficient for the development of an effect which was impossible before: particles of the air enter between the particles of the thread and separate them, thus causing disintegration of the complex. A tektological boundary passes through it.

As we can see, it passed where a complete neutralization of activities had occurred, which we shall call a "complete disingression."[1]

To this day there is still a notion about "empty space," or the absence of any environment. But this is completely erroneous; it contradicts the entire sense of contemporary science. At each point of this "emptiness," the interstellar ether, any body put there experiences the influences of electrical magnetic and gravitational forces; the same forces which in other more complex combinations characterize the well known "material" environment.

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[1]This name denotes the fact which is opposite to that of ingression. In ingression the activities which were not previously connected are joined together creating a "linkage" of the conjugating complexes; in disingression they mutually paralyze each other, thus leading to the creation of a "boundary," i.e., separateness. As long as they do not paralyze each other completely, the boundary does not exist: this is only a ***partial disingression***; it is always added to any ingression because as we have seen, there is not a conjunction of complexes without some expenditure of their activities in the form of mutual resistances.

If the resistance of the ether environment is very small, this means that it is composed of complexes which are least organized. A resistance, however, exists; although, for example, for a moving body it is infinitely small with normal speeds, but with their increase it also increases; and when the speed approaches that of the speed of light, it grows to an infinitely large magnitude, i.e., becomes practically insurmountable. Consequently, an environment is always present; and therefore a complete disingression always causes an intrusion of the elements-activities of the environment on lines of the destroyed resistances; that is, the creation of a tektological boundary.

A vivid illustration of a tektological boundary and also the changes in it is the front line. It passes through the points where the antagonistic efforts of two armies are held in mutual balance, and for as long as they are so held. As soon as this balance is distrubed, as it happens with an attack by one side, the front line disappears; this gives rise to conjugating processes— battles and skirmishes in which elements of both sides intermingle in various combinations and interactions. Subsequently, military activities may again come to a balance along a new front line; or conjunction may spread further and further and culminate in the creation of a linkage, embodied in a peace agreement or a relationship of conquest and subordination. Another illustration is the boundary between the "north" and "south" halves of the magnet; it is also caused by a mutual neutralization of opposite activities, and can also shift when this correlation changes because of the approach of other magnetic masses or electrical currents. Another example is the main points of standing waves in a vibrating body: these points appear where opposite fluctuating motions are paralyzed. Everywhere, all boundaries have one and the same basis: complete disingressions.

A breach in the tektological boundary between any two complexes generally constitutes the start of their conjunction, the moment when they cease to be what they were,that is, tektological separatenesses, and when they begin to create some new system, with further transformations, the appearance of linkages and partial or complete disingressions; in sum, this is an organizational crisis of given complexes. The creation of a tektological boundary which produces from a given system new entities, also makes the system, in the organizational sense, different from what it was before; this is also its crisis, but of another type. All crises observed in life and nature, all "upheavals," "revolutions," "catastrophes," etc., belong to these two types. For example, revolutions in society usually represent a breach in the social boundaries between various classes; the boiling of water, a breach in the physical boundary between the liquid and its atmosphere; the propagation of a living cell, the creation of a vital boundary between its parts which acquire independence; death, a breach in the living bond of an organism through paralysis of its activities at some points by others which aim in the opposite direction, etc.

For the sake of conciseness, we shall denote crises of the first type as "crises C," the second as "crises D."[1] On the basis of the foregoing it is obvious that crises C are primary: any division is preceded by conjunctions. Thus, the division of the mother cell into daughter cells is a result of its growth and nourishment, i.e., the conjunctive ingestion of elements from the external environment; death is the result of the entry of external activities into an organism; this entry may be fast and unusual with a violent death, or severe infection, and gradual and consecutive with death from old age or illnesses involving an exchange of substances, etc.

Conjunction, ingression, linkage, disingression, boundary, and crises C and D are the basic concepts for the formulating tektological mechanism; they will serve us in the investigation of the most varied cases of the creation of organizational forms, complexes and systems. But there later appears a question concerning the fate of forms that have appeared, such as their preservation, consolidation, diffusion, or their decline and destruction. This is the question concerning the regulating tektological mechanism.

2. The Regulating Mechanism

i. Conservative Selection

All that appears has its own fate. Its first and simplest expression reduces to the dilemma: preservation or destruction. Both the former and the latter are governed by laws, so it is frequently possible to foresee the fate of forms. *Lawful preservation or destruction* is the first scheme of the universal regulating mechanism. It is best to denote it by the name it received in biology, "choice" or "selection." We are going to discard, however, the addition of "natural," since for tektology the distinction between "natural" and "artificial" processes are not of primary importance.

The notion of selection, having appeared first of all in biology, is, as we have already said, nonetheless universal: the organizational science must apply it to all complexes, their systems, connections and boundaries. In order to illustrate this generality, let us take a number of examples of the most heterogeneous character.

Climatic changes occur in a country: it becomes colder. Of the animals and plants inhabiting it, some are able to endure this change and survive; others perish. As a result, the organization of life on a given territory is regulated in accordance with new conditions.

Instead of a change in climate, let us assume the entry of man who did not live there

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[1] That is, "conjunctive" or connecting, and "disjunctive" or separating.

before. He destroys certain organisms, takes away the means of nourishment from others, supports the third directly, helps the fourth indirectly by destroying their enemies, etc. Tektologically, this is as similar a case as the previous one: the organization of life is being regulated in accordance with the situation. The influence of man, whether planned or unconscious, is for each living form the same external activity, as useful, harmless or destructive as the change in temperature or humidity.

A city is subjected to a fire. Wooden buildings mainly perish and stone buildings are preserved. The same city happens to be in the area of an earthquake; multi-storied and wooden structures crumble, one-storied and brick structures endure.

An ear of barley with its beard in a downward position is thrust into the sleeve of the clothing of a walking man. It receives jolts in all possible directions; all downward movements are destroyed by the resistance of the beard, but the upward movement is free: the ear rises up the sleeve.

Here a number of complexes-events, which follow one after another in time are subjected to selection, whereas in the previous examples the question concerned complexes-bodies existing simultaneously. The tektological scheme is not at all changed by this.

If a box, in which lie irregular pieces of broken sugar, is shaken from side to side, then the pieces will gradually locate themselves so as to have the centre of gravity of the entire mass occupy the lowest possible position. With various jolts those movements of the pieces which raise the centre of gravity are destroyed to a greater extent than those which lower it, because the former encounter the resistance not only from frequent accidental jolts of the opposite direction, but also from the constantly active earth gravity and the weight of the pieces of sugar.

If a man falls into a difficult situation, then new experiences are primarily retained and fixed in his psychics; and mainly those which have a gloomy, painful character, corresponding to the new situation, surface in his consciousness from the previous experiences; similarly in the opposite case: psychic complexes are selected by the external environment.

In a society, in its separate class or any collective out of newly appearing human groups, relationships or ideas, those are retained and preserved which correspond to the permanent and common conditions of its life, and those disintegrate and disappear which are in opposition to them; this is the selection of social complexes.

Comparing these various illustrations, it is easy to see that the tektological scheme of selection differs from the "natural selection" of biologists only in the necessary simplification or reduction. Biological selection assumes propagation to be related to heredity; the general organizational scheme cannot include this because propagation is a special feature of living organisms.. Tektology takes points of departure for its constructions from special sciences, but it is forced to change the borrowed concepts, adapting them to the universality of its problems. So it was with the previous concept of "conjunction."

The universality, however, of the scheme of selection is such that it is obviously applicable to any complex and any of its parts at any time; for this, in essence, is simply a definite point of view from which any fact can be approached. Man lives, that is, he is preserved in his given environment; consequently, a regular correspondence which is sufficient for this exists between him and the environment; he dies— consequently, such a correspondence does not exist; this or that cell of his body lives as long as it is adapted to its environment; that is, first of all to the organism itself and through it to the external world— it perishes when this correspondence is violated to a sufficient degree, as does any element of the cell, any of its partial connections, etc.

Mankind in its practice constantly applies, at each step, the same point of view in reality, i.e., it operates by means of selection. Even in a specially biological sense people have carried out semi-consciously the "artificial selection" of domestic animals and cultivated plants, producing the most suitable forms of both, and they had done this thousands of years before "natural selection" was discovered: this is one more illustration of the inescapable unity of the organizational methods of man and nature. And in the general organizational sense, all production, all social struggle and all cognitive work are carried out constantly and steadfastly by means of selection; that is, through systematic support for complexes corresponding to the vital goals of people and the destruction of those which contradict those goals.

For example, people in all countries destroy predators and other "pests," breed domestic animals and protect useful wild animals, destroy poisonous plants and useless "weeds" that compete with the useful, and cultivate useful plants which satisfy human needs. The same is true of inorganic nature: people destroy or remove certain complexes and protect others; blast rocks, sometimes dynamite entire mountains, drain swamps and lakes, protect shores from erosion, strengthening them in a special way, etc. In mining minerals and metals, man destroys certain mechnical and chemical connections of mountain rocks, while preserving others which already exist or are created by his efforts. This also generally relates to the production of any product: production necessarily contains a moment of selection which regulates the entire process of changes in the material on the way to the final product; a change which corresponds to the problem on hand is preserved; what does not correspond to it is removed by a new influence.

The struggle of classes and groups in society is always directed to the destruction of certain social forms and relationships and the support and strengthening of others in conformity with the interests of the struggling collective. Selection plays as great a role in the processes of cognition, where its two features are expressed by the notions of "affirmation" and "negation." Reflection, meditation and the solution of questions consist precisely in the fact that from a great many combinations, entering the field of thought, certain are accepted as "successful" or "true" and others are rejected as "erroneous" or "false."

The more complex and difficult is a problem for people, the less they are prepared by experience to provide a systematic solution, the more important becomes the mechanism of selection. The history of scientific discoveries and inventions provides vivid illustrations of a long "search" involving the generation of numerous combinations which are rejected one after another until the one which fully corresponds to the problem is obtained.

In Ehrlich's famous discovery of "606," the mechanism of selection is both a principle of decision-making and a method of search. The first consisted in the need to discover a catalyst, in this case a chemical substance which would destroy the pale spirochete, or syphilitic microbe, with little damage to the cells of the human organism. Then, by introducing a well proportioned quantity of this poison into the blood, it was possible to carry out the selection under which spirochetes would perish and cells of the organism survive, thus eliminating the cause of the illness. Ehrlich looked for such a substance, examining various organic combinations of arsenic and rejecting one combination after another as unsuitable until the six hundred and sixth attempt yielded a satisfactory result, and the nine hundred and eighteenth, in certain respects, an even better result.

For tektological investigations the mechanism of selection must be clearly represented both in its entirety and parts. It decomposes into three elements:

1) the *object* of selection, or that which is being selected, such as living organisms in the scheme of Darwin; buildings and structures in the example of an earthquake; shifts of things in the examples of the ear of barley and the box of sugar; connections and correlations of things in technical selection of labour; connections and interrelations among people in the selection during a social struggle, etc.

2) the *agent* or *factor* of selection, or that which acts on the object of selection by preserving or destroying it, such as living conditions in the scheme of Darwin; mechanical resistances in the example of barley ear; analogous resistances in the example with the box; the activity of people in industrial selection, etc.

3) the *basis* of selection, or that aspect of the object on which depends its preservation or elimination, such as useful adaptability or features of unadaptability in "natural" selection; direction of displacement in the examples of the barley ear and the box; correspondence to human needs in technical selection; correspondence to the structure of society in social selection, etc.

The first scheme of selection, which concerns only the preservation of organizational forms or their non-preservation, can be denoted by the term *conservative selection*.

ii. Dynamic Equilibrium

Tektology is concerned only with activities, but activities are characterized by the fact that they produce changes. From this point of view it is out of the question to think about a simple and pure "preservation" of forms, one that would constitute a real absence of changes. Preservation is always only a result of immediately equilibrating each of the appearing changes by another opposing change; it is a *dynamic equilibrium of changes.*

The organism in its vital activity constantly expends, *loses* and returns its activities to the surrounding environment, in the form of the substance of its tissues and energy of its organs. This does not prevent it from remaining approximately or practically *"the same;"* that is, it is preserved. In exchange for the expended activities, it just as continuously takes and *assimilates* elements of its activities from the surrounding environment, in the form of food, energy and sensations. During weeks and months, the composition of the main, most plastic tissues of our organs is completely renewed; during several years, even the composition of our skeleton. It is preserved in the way the form of a waterfall is preserved with the constantly changing material of its water. This is a dynamic equilibrium of the exchange of matter and energy between the living or inanimate complex and its environment.

Dynamic equilibrium is infinitely spread in nature; it alone provides a possibility of finding stable complexes in nature, whatever they are, without which cognition would be generally inconceivable. And as science developed, it became more and more clear that where only stability and invariability appeared to naive perception, there was really nothing but motion, and that two currents of opposite changes produce a static illusion. Body temperature remains the same only when it gives to the environment the same amount of heat fluctuations as it receives from it; the neutral electrical condition of objects surrounding us remains the same, only with the same exchange of electrical energy. The sea lives in the rotation of its water, which it gives to the atmosphere in the form of steam, and receives back from the environment in the formof precipitation and rivers and streams carrying into the sea water precipitation from the land; the atmosphere has the same rotation of its gases, in which its chemical composition is maintained, etc.

Any chemical stability, with the deepening of scientific investigations, reduces more and more to an equilibrium of opposite, exchanging reactions; and there are grounds to suppose that the same will be found in the future with regard to the stability of the electronically powered composition of atoms.

Formerly, dynamic equilibrium was considered to be a special property of living bodies. Biologists gave to its two sides, the two currents creating it, the names *assimiliation* and *disassimilation*, that is, literally, "likening" and "dislikening." The first denotes the assimilation of elements from the external environment during which these elements, having entered the composition of a given complex, create in it groupings "similar" to other groupings of the complex, that is, are likened to them; the second denotes dissassimilation of elements, their loss to the surrounding environment during which they enter into new combinations, unlike the former ones. For us, the same terms will refer, of course, to any organized complex and to all possible tektological forms.

Dynamic equilibrium is never absolutely precise: there cannot be a complete, absolute balance of opposite changes; it is always only approximate and practical; in other words, dynamic equilibrium or the preservation of forms can be asserted only if the difference between assimilation and dissasimilation is practically and sufficiently small enough to matter, so that, the complex can be considered as being "the same;" that is, as being preserved within the limits of time relating to a given problem. Thus, if the question concerns man, as a labour force, then it is possible to consider this labour force as being preserved as a constant magnitude for economic calculations only within the limits of weeks, months and sometimes years, but no longer; but for precise physiological investigations this is quite different: within the same limits quite perceptible changes are revealed in both directions which are important for scientific calculations.

Tektology should consider any preservation of forms as their dynamic equilibrium and any dynamic equilibrium as a practically relative equality of the two processes of assimilation and disassimilation.

iii. Progressive Selection

Thus, precise preservation does not exist, and approximate preservation means only practically small changes in the direction of the preponderence of assimilation over disassimilation, or vice versa. Already this makes the scheme of conservative selection scientifically inadequate. But this is not all. It is generally difficult to apply this scheme to those cases in which the form changes and develops progressively: to call this simply preservation would be imprecise, and such changes certainly cannot be denoted as destruction.

Meanwhile, it can proved that the real preservation of forms in nature is possible only through their progressive development, without which "preservation" inescapably reduces to destruction, even if it is imperceptible for the ordinary methods of investigation. And the majority of "preserved" complexes in our environment are exactly in such a situation; they are slowly and imperceptibly destroyed.

In an eastern fable, the notion about eternity is given by the following comparison. At the extreme end of the world there is a diamond mountain, one hour of travel in length, width and height. Once every hundred years,a little bird flies by and stops on this mountain for one minute, cleaning its beak against it. When the entire mountain is erased to its very foundation by the repetition of this operation, then the first second of eternity will pass. This picture, of course does not illuminate the notion of eternity; it is a negative notion. But apparently, if the diamond mountain is not experiencing any other changes, apart from the ones mentioned here, then, although from a practical point of view it is preserved for quite a long time, in a precise theoretical formulation this complex is being decomposed all the same. It is quite likely that the atoms of some chemical elements are being decomposed at an even slower speed than the diamond mountain; but for contemporary theory on the structure of matter there is only a *quantitative* difference between the disintegration of such elements: there are some emanations with an average period of atomic life equal to a fraction of a second, and there are emanations with a period equal to approximately one trillionth part of a second. In practice, quick and slow disintegration have quite different meanings for us; but in scientific analysis this difference is only the question of a coefficient.

Let us suppose that we are successful in ascertaining that complex *A* does not disintegrate at all, and that it does not experience changes in the other direction in the sense of the preponderance of assimilation over disassimilation, i.e., an increase in the sum total of its activities. In this case we would have had before us a pure, ideal statics; but it is easy to be convinced that this condition could not be retained, and would inevitably collapse. Complex *A* happens to be in a definite environment and in full dynamic equilibrium with it; and as long as this environment remains *the same*, the equilibrium is guaranteed. But the environment can by no means be unconditionally stable: it is connected with the current of world events, and with strict analysis, it spreads in the end, to the entire universe; consequently, the environment *inevitably* changes. Apparently, with the environmental changes also change the relationships of complex *A* to its environment. Can these changes be favourable to it? Yes, but only accidentally and, therefore, only temporarily. In general, however, changes in the environment which occur independently of a given complex are much more often unfavourable to it because the number of unfavourable possibilities, as evidenced by the entire experience of mankind, is incomparably greater than the number of favourable ones; this can be compared to the probability of directing a ship without a rudder and sails, during storms and currents, to its appointed destination. Consequently, in a changing environment,the static condition of complex *A* is inevitably converted into an unfavourable position: first of all the preponderance of losses over assimilation, then decay.

Thus, for preservation in a changing environment, in the final analysis any environment, it is insufficient to have a simple and interchanging equilibrium. The only thing which can give a relative guarantee of preservation is the growth of the sum total of activities or the preponderance of assimilation; then the new unfavourable influences are encountered by an increased resistance rather than the former one. Nature proceeds exactly in this way in the job of preserving its living forms, and man in his collective self-preservation: by means of the growth of complexes and accumulation in the stock of activities. Each step in this direction increases the possibility of sustaining life under changing conditions. In other words, the *dynamic element of the preservation* of a complex lies in the growth of its activities at the expense of the environment.

Similarly, the dynamic element of destruction should be represented as a diminution of the activities of a complex and their absorption by the surrounding environment. The fact of the destruction of a complex and its disappearance is the result of a process, at times quite involved; but from the quantitative point of view it appears as a diminution of the sum total of activities-resistances. This destruction can be perceived as occurring "instantaneously," as, for example, in the crushing of a boulder by the blow of a steam hammer, or the discontinuance of life in organism due to a discharge of lightening; but this is due only to imperfections in our modes of perception. Theoretically, that is, scientifically, each such event decomposes into a continuous series of changes, successively decreasing the sum-total of the elements of a complex. Breaches of connections forming the content of the process appear, as we know, from disingressions which paralyze resistances of the complex by the opposing activities which are destructive for it and tektologically "external."[1] Each such disingression develops by means of successive intrusions of these external activities; for the generalizing scheme it is immaterial whether the intrusion which paralyzes, i.e. practically takes away, or *disassimilates* the elements-activities of the complex, is fast or slow.

[1]In tektology the word "external" does not have a spatial meaning. Bacteria in the organism and poisons which get into its blood represent complexes which are, in the organizational sense, not "internal," but external to it,because they do not belong to the system of its organizational connections. And those parts of the system which go out of its organizational connections, though spatially located inside it, should also be considered as being tektologically external. For example, cancer cells, the tissue which develops in contradiction to the vital connections of the organism; a criminal with whom the society struggles as an external force, etc. But in this case as in all others, exactly "so far as:" the organizational connection is relative; a criminal, for example, is outside this connection to the extent that he breaks it; in the remainder of his activity he may belong to it as before.

We come now to a new understanding of selection based on the idea of dynamic equilibrium and the departures from it. This scheme is broader and deeper; it embraces both the progressive development of complexes and their relative decay; it decomposes processes of preservation and destruction into their elements. It is most expedient to denote it by the term "progressive selection:" it is *positive* with a growth of the sum total of activities of the complex, that is, under the preponderance of assimilation over disassimilation; ***negative*** with a diminution of the sum total of activities, that is, the preponderance of disassimilation.[1]

Here is one of the simplest examples of such selection. "In the hollow of a leaf lies a drop of dew. Water molecules continuously "evaporate" from its surface (disassimilation); at the same time other molecules fall on it from the atmosphere (assimilation). In a saturated and humid atmosphere both processes are equal, and we have a dynamic equilibrium. When the air is oversaturated with moisture, as a result of the lowering of temperature, the condensation of steam preponderates and the drop grows in size; this is progressive selection in a positive form. When the saturation of the atmosphere with steam is partial, then there is a negative form of progressive selection."[2]

Other examples include: the growth of a cell in a favourable environment, giving it a preponderance of nourishment over expenditure of matter and energy; a gradual diminution in the content of a cell; and its "emaciation" in the environment of poor nourishment; the growth of society, as an organization of human forces, when production is greater than consumption; and the diminution in the sum total of social activities in the opposite case; the rise in the quantity of heat in a physical body when it absorbs more heat than it loses to the environment; and the fall, when losses preponderate; the intensification of sound produced by a resonator when it receives a greater quantity of energy in the form of waves, corresponding to its frequency and, consequently, assimilated by it, than the quantity which it loses in the form of waves emanating from it; and the weakening of sound under the contrary conditions, etc.

The results of progressive selection are, of course, expressed, first of all, in an ***increase or a decrease in the number of elements in a complex***; the increase or decrease of elements reduces to the same thing, if they are sufficiently analyzed further by decomposing them into smaller and simpler ones. For example, positive selection for a mature organism may

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[1]The word "selection" here, obviously, departs from the original meaning; but it corresponds best to the inner sense of the expressed correlations and their connection with the previous scheme. "Progressive," however, is taken here not from the word "progress" but from the word "progression," i.e., a continuous series of events directed in this or that way.

[2]Tektology, Vol. 1, p. 63.

not be accompanied by an increase in the number of its cells, but rather reduces to the growth of these cells; but the latter means an increase in chemical and physical activities entering into the composition of cells and, consequently, into the structure of the organism as a whole. But these quantitative results of selection do not at all exhaust the question.

A dew drop has the form of a slightly flattened ellipsoid. This form depends on its general structure and, in particular, on the correlation between the weight of particles and their couplings; the surface layer, because of the couplings, represents a kind of tight film which supports the form of the drop. The drop grows in the air which is saturated with moisture, but with sufficiently precise observation it is easy to note that its form also changes; it becomes more and more flattened. This apparently means that the structure of the drop changes. If progressive selection continues, then the flattening of the ellipsoid is joined by a gradual stretching of the drop along the same axis; and the drop finally divides. The accumulated changes in its internal structure have led to a crisis.

Negative selection— in our example, a gradual evaporation of the drop— also changes its form, which testifies to the changing internal correlations. The form of the drop becomes more and more regular and closer to a regular sphere; and finally, the progressive diminution of the drop leads to its disappearance; this is another crisis.

The same can be said of any other event of progressive selection: with an addition of new or a decrease of former elements the internal correlations of the complex or its structure also change. In a living cell, processes of growth change molecular connections, what is at first expressed in a certain variation of its form, and then in its division into equal cells daughters, or in a separation of parts from it by "gemmation," etc.; with the insufficient inflow of matter and energy, in addition to changes in form, the destruction of the cell is sometimes observed, sometimes the formation of a protective cover around it,accompanied by a weakening of the entire life exchange system, and sometimes the formation of spores with similar covers, etc. The preponderance of absorption of heat energy over expenditures also causes transformations of molecular connections in physical bodies, leading to crises of melting and boiling, and sometimes also to a transformation of atomic connections, leading to chemical reactions. Everywhere, growing changes in structure pass into crises at a certain level.

In the most general form, it is also possible to determine the character of these structural changes. Under positive selection, as we have seen, the form of the drop becomes less regular and geometrically more complex. At the same time it turns out that it is easier to divide the drop into parts and its resistance to division relatively lessens; and later, with sufficient growth, it divides under the force of its own weight.[1] All this apparently points to the *growing complexity and heterogeneity of the internal relationships of the complex.* This also holds for all other similar cases, and is understood a priori: new elements bursting into existing connections, of course, complicate them and disturb whatever degree of homogeneity they may have.

Under negative selection the form of the drop becomes geometrically more regular and simpler, and its resistance to division relatively grows. This indicates the *simplification of the internal structure and an increase of its homogeneity*; this is an opposite tendency to the former. And it is just as easily understood: under the influence of the environment, first of all, those elements separate which are least firmly coupled with the whole, and whose connections lessen the homogeneity of the whole; but a diminution in the number of connections and an increase in homogeniety precisely a simplification in structure.

These characteristics are operative within certain limits, until selection brings about a crisis; and then comparison becomes more difficult, because the form itself is considered to be qualitatively different from the one which existed before; the direction of selection may also change sharply. For example, the industrial capitalistic system of production under conditions of positive selection— so-called "prosperity"— has certain definite properties; these properties are sharply replaced by others with the approach of an "industrial crisis," and the sign of selection also becomes negative.[2]

Although, as we have seen, the conservative scheme of selection is less perfect than the progressive scheme, it does not follow that it is always more correct and expedient to apply the latter. Conservative selection is especially related, both in practice and theory, to questions of the *development* of given complexes. Therefore, it is especially important and useful where such a development may practically *depend on our actions*, or where it is sub-

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[1]The reason is that the form of the drop is maintained just by the surface layer of molecules, its tension. But this surface film, according to geometric laws, grows not as fast as the volume of the drop and with it also its weight. However, the pressure of its parts deforming the drop depends precisely on their weight; consequently, it enlarges faster than the resistance of the film; the correlation of both determines the changing form of the drop, and then also its division— when its weight exceeds the coupling force of the film.

[2]In mathematical analysis there is a special symbol for the expression of the progressive selection of "magnitudes," i.e., measured complexes; this is a *derivative*. When its sign is plus, it means positive selection; a minus sign means negative selection. When it becomes zero or infinity or is interruped or changes its sign— this corresponds to crises of real numbers. One of the simplest examples: with the motion of a body, the derivative of distance with respect to time is velocity. When it is greater than zero, the distance grows; when less than zero, it decreases; when it is equal to zero— this is *the crisis of halting* the motion.

jected to a theoretical investigation. Pedagogy can serve as an example of the first scheme; the problem here lies precisely in gaining mastery over the development of the future member of society, and controlling and systematically directing this process. As examples of the second scheme are the theory of the formation of individual psychics in psychology, and the theory of economic growth and the theory of ideologies, etc., in the social sciences.[1]

In those cases when the given complexes, according to conditions of a practical problem or the limits of investigation, do not perceptibly evolve in this or that direction, but only serve as ready material for more complex formulations, it is necessary to apply the scheme of conservative selection. There are numerous cases of this in practice when it is necessary to single out what is suitable for the attainment of a given purpose from the given materials, such as the extraction of gold from ore, the selection of workers from a great number offering their services for a certain job, the selection of the best means or methods from a number of possible ones, etc. Illustrations in the field of theory include numerous statistical mass events, such as the diffusion of waves with the mutual destruction of the great majority of vibrations and preservation of those which follow a few definite lines; the influence of sharp changes in the environments on flora and fauna; the influence of historical catastrophes on the structure of society, etc.

It is evident that the regulating mechanism is not something separate from the formulating mechanism: with sufficient analysis any process of positive or negative selection decomposes into innumerable elementary changes– conjunctions with ingressions and disingressions arising from them. In essence, these are two different points of view in the tektological investigation; both of them are indispensable and complement each other. Having gained a mastery over them in the most general terms, we can now turn to a closer investigation of actual organizational processes.

[1] In relation to the theory of psychic development and, partly, pedagogy, I succeeded in showing how many important conclusions are derived by systematic application of the scheme of progressive selection (see Tektology, Vol. 1, Chapter "Hedonistic Selection," pp. 75-89, and Empiriomonism, Vol. II, the entire article, "Psychic selection," where the question is considered in detail, but tektological methods are still insufficiently worked out.)

IV
Stability of Organizational Forms

1. Quantitative and Structural Stability

The drop of water in both saturated and unsaturated atmosphere with steam has served for us as an example of positive and negative selection. It can also be taken as an illustration of the two basic concepts which relate to the organizational stability of forms.

If the air is not saturated with steam, the drop evaporates and loses its elements to the surrounding environment. After some interval of time under these conditions, it must disappear altogether: this is a crisis of the destruction of the given complex. Assuming that the humidity and temperature of the atmosphere remain unchanged, the duration of the drop's existence depends on its size: a large drop is preserved for a longer period of time than a small one. A complex embracing a more significant sum of elements is thereby characterized as a ***more stable*** complex in relation to its environment, but only in a strict quantitative sense, i.e., as possessing a larger sum of activities-resistances opposing this environment.

Positive selection obviously leads to a growth in this "quantitative stability," negative selection to its decrease; or even more precisely, positive selection is identical with its enlargement, and negative selection with its diminution; for the first is defined as the preponderance of assimilation over disassimilation, i.e., as a growth in the sum of elements in a complex, the second being opposite to this.

But the actual, practical stability of a complex depends not only on the quantity of activities-resistances concentrated in it, but also on the mode of their coupling and the character of their organizational connections. We know that under positive selection, along with the size of the drop, the heterogeneity of its structure also grows; for example, the mechanical division of the drop can be attained relatively easier, and at a certain limit the weight of the drop is itself sufficient to divide it into two. This represents a decrease in the "structural stability" of the complex. On the contrary, negative selection, along with a decrease in the size of the drop, leads to a growth in the homogeneity of its structure; and inasmuch as this is so, the same effort to divide the drop requires the application of a relatively greater force; this means that its "structural stability" grows. Certainly, this also occurs within limits, only as long as the basic structure of the drop remains the same, i.e., until a crisis, to which negative selection inevitably leads if it continues further and further: in this case, until the crisis of the "disappearance" of the drop as a liquid body.

Structural stability itself represents a magnitude and can always be expressed quantitatively. So, in mechanics, all kinds of coefficients of the resistances to bending, breaking and winding are precisely the quantitative expressions of the structural stability of various bodies in relation to definite external influences. The coefficients of "mass" and "energy" also characterize quantitative stability.

Two complexes of the same type, composed of homogeneous elements-activities, can be directly compared according to their quantitative stability, without taking into account the influences of the environment: if the sum of elements in complex A is greater than the sum in B, then this stability is in any case correspondingly greater under the same influences, no matter what they might be. For example, as an organism grows, its resistance to the action of poison increases in any case; whatever poison is used, more poison is needed in order to disorganize a greater quantity of tissues. On the contrary, structural stability must always be related to particular influences, and not to any influences in general; an organism presents greater resistance to one kind of poison than to another. For each destructive influence there is a special coefficient.

However, the concept of structural stability must be frequently applied in a form which is not so definite. If complex A finds iself in a more or less stable environment, under a certain totality of influences which change only within known limits, such as man in his social environment, or an animal or plant in its usual natural situation, then it is possible to form a summary representation of stability relative to this entire system of conditions. Thus, when comparing two different political or cultural organizations existing within the frame of the same society, it is possible to conclude that one of them is structurally better adapted than another, i.e., structurally more stable. But if social conditions undergo an unusual change, such as a revolution, war or economic crisis, then the correlation will generally turn out to be different, sometimes quite the opposite.

Contemporary theories on the structure of matter assume that atoms, in general, gradually disintegrate in their universal environment, although there is not as yet a clear understanding as to the character of the destructive influences. But we know that for radium the average duration of atomic life is about 2,500 years, for thorium— minutes, seconds, miliseconds. It is these numbers that represent summary coefficients of structural stability of the given forms of substance in those usual conditions under which they are ordinarily observed and the boundaries of which experiments are unable to cross so far. When science succeeds in explaining those influences on which the decomposition of atoms depends, and in systematically changing its speed for different bodies, then not only will the theoretical question concerning conditions of their structural stability be solved, but also, practically, mankind will have at its disposal gigantic quantities of activities of "intra-atomic energy."

The notion of structural stability within the bounds of a limitedly changeable environment has enormous significance for tektological practice. The entire environment of life on earth, the entire environment in which mankind acts and evolves, with its usual amplitude of fluctuations in the various conditions of its astronomical, atmospheric and other cycles, may be considered as limitedly-changeable; and this means exactly the environment in which changes are scientifically considered in advance, either in their totality or in broad summary combinations.

Propositions on how structural stability is influenced by progressive selection, both positive and negative, are especially important. We saw in the example of the dew drop that under positive selection this stability decreases with the growth in heterogeneity of the internal couplings of the complex, but increases under negative selection with the growth of homogeneity. The same is true of any complex in an environment of indeterminately changeable and varied influences: in the first case, the existing structural contradictions are retained,and are joined, with an entry of new elements, by new contradictions; in the second case, the ongoing destruction first detaches the elements which are least firmly connected with the complex; it breaks down the most contradictory couplings or those which are most closely related to partial disingressions. For example, the growth of a living cell, parallel to the growth of a dew drop in a saturated atmosphere, leads to the accumulation of internal disingression,which is also expressed, finally, in the division of the cell into two; in biological evolution this division is utilized as "propagation;" but the drop, having divided in a saturated atmosphere, has also "multiplied," because its parts, or "drop-daughters," continue to grow under the same conditions as it had done prior to the new division; the same is true of cases of "propagation" in liquid crystals etc.

This regularity appears with particular clarity in the lives of organisms and society. When, for example, man lives in a particularly favourable situation then, despite the accumulation of energy in quantitative terms, the general strength of his resistance to the environment begins to fall; as the saying goes "he becomes delicate," and this means a decrease in his structural stability against unfavourable influences. On the contrary, in many cases just after moderate starving, a not too excessive loss of blood, or a sharp feverish illness, a recovery which leads to better health than that which prevailed before the period of negative selection is observed; and "health" is a designation for the same structural stability of the organism.[1] Capitalism with its crises provides a mass of examples of hidden contradictions which accumulate under conditions of "prosperity," i.e., the conditions of positive selection. These contradictions begin to strike the eye, particularly under long periods of prosperity. Thus, England, after centuries of prosperity in the epoch of its rule in the world markets, was also distinguished by the development of economic extremes: it had gigantic wealth and the deepest poverty, and preserved backward ideologies side by side with progressive ones; it was a country of the greatest piety and obsolete political traditions, etc. And if we consider the social classes which lived in an exceptionally favourable situation, i.e., the ruling, exploiting classes of different epochs in history, we find that they usually ended in degeneration. On the contrary, severe conditions have often led to the revitalization of nations: from difficult wars, after a great expenditure of energy, they often emerged as if renewed, more internally united and more active at work; they were able to quickly rebuild what had been dissipated, and rose higher than before.[2]

The total stability of a system in relation to its environment is evidently a complex result of the *partial* stabilities of its various parts in relation to those influences which are directed against them. It is necessary, therefore, to find out what exactly is the connection between the stability of separate parts and the whole which they compose.

2. The Law of the Minimum

Let there be a chain which is composed of links of unequal strength. On this chain weights are suspended. Most of the links are able to sustain the weight of 1,000 kgs without

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[1]Of course, such a recovery does not always happen: negative selection is also related to a gradual destruction which causes structural stability to fall; the question concerns the extent of destructive processes; generally, their significant development brings about disorganization.

[2]The content of the previous reservation also applies here.

breaking, some of them the weight of 1,500 kgs, and one of them only the weight of 500 kgs. What is the maximum weight that the chain as a whole can support? Obviously, only 500 kgs; with a greater weight the chain will break in the weakest link. The structural stability of the whole is determined by *the least* stability of its parts. This scheme applies not only to mechanical systems, but to all systems: physical, psychic and social systems, to name a few. If an organization of people, such as an army, is to overcome destructive influences, then its stability depends on the least stability of its parts; and in exactly the same way, a logical chain of proofs falls to the ground if one of its links does not sustain the blows of criticism.

But in practice a system is not subjected to equal and uniform influences at its various parts. Even in our example of the chain, its higher links must sustain in addition to the suspended weight, the weight of all lower links; this may sometimes constitute a decisive difference; a military front is not subjected to blows of a uniform force at different points and times, etc. It is, therefore, necessary to introduce the concept of a *relative resistance.* In the mechanism known as a pulley, one rope must sustain, with the lifting of weights, one thousand kgs, while another must sustain only 500, the third 250, the fourth 125, etc. If the first rope is able to withstand a tension of 1,500/1,000, i.e., 1½; if for the second the limiting tension is 600, then its relative resistance is 1 1/5; if for the third it is only 250, then its relative resistance is equal to 1; this will lead to a full disingression between the couplings of its parts and the influence of the weight and, as we know, the rope will break. Moreover, it will break if the relative resistance becomes less than one at any of its parts.

If the magnitude of external influences is changing or the structural state of the system is changing, then it is sufficient for any of its parts, for no matter how short a period, to have a relative resistance of less than one for the destructive processes to occur; their significance and depth will depend, of course, on the sum total of organizational conditions. A giant who falls asleep for just a moment can be killed by an insignificant dwarf. It is sufficient for the epidermis of a human body to be damaged by a small wound of 1/10 of a millimeter in length and width— what constitutes less than a hundred-millionth part of its surface— and for pathogenic microbes to have actual access to it, if only for a second, and the organism becomes infected, perhaps mortally.

The stability of the whole depends on the least relative resistances of all of its parts at any moment of time;[1] this law is of enormous practical and scientific significance.

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[1] Continuing even further to particulars, the same law determines the inescapable historical limitation of the "authoritarian" type of organization. It is characterized by the fact that the "organizational function," i.e. structural adaptability of the entire system, depends entirely on the *individual* brain of the "authority" or ruler, whereas the scale of organized life is, of course, *collective*. Consequently, a partial and even temporary individual inadequacy is reflected, at times irretrievably or even ruinously, on the entire collective.

By the way, technical, political or any other "responsibility" is based on this law in organizational practice. A leader may have been successful for many years in carrying out his tasks correctly and expediently, maintaining at all points an adequate stability of the organization by timely and able interference, but if on one question his intellectual energy betrays him or his attention simply falters for a moment, then an irreparable damage often occurs as a result, and, sometimes, as it happens in a battle situation, the result is complete ruin.

It is necessary to remember that the notions of "activities," "influences," and "resistances" are for tektology entirely correlative and interchangeable when the point of view, the initial point of analysis, is transferred from the complex to its environment. Therefore, the scheme of "the least relative resistances" of the various parts of the complex is fully equivalent to the scheme of "the least relative activities" of those same parts; that is, "the greatest relative influences" of the environment to its greatest relative resistances; and many cases which are not embraced in their external forms by the first expression we introduced fall under the same formula.

Let there be a squadron consisting of vessels with different speeds, different draughts in the water, and different volumes of coal holds. Let the speed of line battleships be 30 kilometers per hour, cruisers 40 kilometers, and destroyers 50 kilometers. What will be the common speed of the squadron on an extended voyage? The speed of a vessel is a measure of the *surmounted resistances* of its water environment, or a measure of the *activities* of the complex *itself*; the least relative magnitude of these activities is equivalent to the greatest relative magnitude of the opposing resistances, which is, obviously, expressed by the slowest speed, 30 kilometers. Indeed, such ought to be the common speed of the squadron, the greatest speed under which it can still maintain communication and unity of action; those vessels which develop a significantly greater speed will break away from the battleships and scatter the squadron.

Further, let the submerged part of the battleships extend 10 meters, that of cruisers 8 and that of destroyers 5. The squadron must pass through the relatively shallow waters of some strait. Which of the most shallow channels will be accessible to it? Here it is more convenient to talk about the greatest relative resistances of the environment; it is clear that they correspond to the greatest draught, 10 meters; the other vessels will pass where the battleship does, but not vice versa.[1]

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[1]There is an anecdote about an engineer who offered a locomotive driver to go through a tunnel, 10 archines (1=28 inches)in height at one end, 6 at another, and the average of 8 archines, when the locomotive with a funnel was only 7 archines in height. To be sure, such engineers do not exist. However, former statisticians often accepted as a measure of "social well-being" the average income of population. Assuming income tobe a measure of socially crystallized activities-resistances which are at the disposal of people to support themselves against the elemental forces, magnitudes which express the level of social well-being should be the incomes of the lower strata of society.

Similarly, if one ship has in its coal pits a supply of coal for a voyage of 10 days, others for 15, still others for 20, then the greatest distance from one coal station to another must not exceed 10 days' supply of coal, etc.

It is necessary to bear in mind that the tektological notion of a "part" is far broader than its usual meaning. Let us assume that it is necessary to drag a body of a certain form through an opening whose walls have an unknown resistance to a given activity: such as carrying furniture through a door, or having a prisoner climb through filed prison bars, etc. It is necessary to consider "the greatest relative resistances of the environment;" and they are most significant for the greatest cross-section of the body, and even more precisely, for the greatest dimension of each cross-section. Consequently, the body will go through only if none of the dimensions of its cross-sections exceeds the corresponding dimension of the opening; otherwise, the relative resistance of the environment is greater than one in this dimension; that is, it is insurmountable. Cross-sections, i.e. "areas" and even their dimensions or "lines," are, tektologically, parts of a complex, in this case the body.[1]

It is often necessary to consider the relative activities-resistances of a complex and its environment as changing in time; that is, to investigate a complex as a process. Then all the moments of this process appear in the form of links of one temporal chain, and it is necessary to apply the same point of view to these links, as parts of the whole. For example, in a limited territory the question is raised concerning its capacity to sustain population: how many people, under a given technology, can live there? The answer will be as follows: as many as can be fed during the most unfavourable years, with the lowest harvest, etc.; during the years of the greatest relative resistances of the environment.

If a product passes through the hands of several workers in a workshop, or a customer goes through the hands of several officials in a bureaucratic institution, then the number of manufactured products and released clients will depend on the worker and the official performing the smallest number of corresponding operations per hour. It is sufficient for one out of 10 to have an abnormally low efficiency for the work force of the remaining 9 to be paralyzed to a corresponding degree.

To this day, language does not specially adapt itself to the precise expression of or-

[1] A great many contemporary mathematicians are completely unable to visualize that "area" is nothing more than a body of infinitely small, or simply disregarded thickness, and "line," a body of disregarded thickness and width. Such is still the power of scholastic, abstract thought. Meanwhile, it is sufficient to grasp the following. The area of *only* two dimensions which they supposedly "have in mind," just as the line of *only* one dimension, cannot exist in perception because they are invisible and impalpable; they cannot, therefore, exits in representation because it is a trace of perception; by the same token they cannot exist in comprehension, i.e., "thought," because representations serve as the material for comprehension. In fact, of course, mathematicians "think" not what they say in their verbally contradictory definitions, but something quite different– areas and lines accessible to sight and visual representation.

ganizational couplings and regularities; and concepts of activities-resistances are often vague and unclear. As is evident from the above examples, a special effort is sometimes necessary in order to determine what exactly should be considered in this or that case as an expression of the activities of the complex, what as an expression of the influences or resistances of its environment, and also into what parts it should be split for analysis. Initially, it is convenient to take the law in a somewhat different and less strict verbal formula: as the law of the *least favourable conditions* or, in short, as the law of the *minimum.* The least favourable conditions and the least positive magnitudes are assumed to operate for the complex in question. This method of expression is particularly expedient in questions concerning socio-organizational practice– economic, political and cultural practice.

Let there be, for example, a party of "bloc" composition, whose two wings are formed by two social classes, one of which is more progressive than the other. Which of the two classes turns out to be in fact more determining as far as the program and tactics of the party are concerned? According to the outlined scheme of the least favourable conditions, the more backward wing. This answer is unusual and even unexpected because, by and large, the progressive class or layer apparently "leads" the backward class by predominantly working out slogans and providing leaders, etc. True, but the actual limit to slogans and direction turns out to be exactly that to which the backward part of the whole agrees; the bloc connection begins to break up with attempts to go beyond this, as would the connections of a detachment composed of infantry and cavalry during a march if the cavalry does not limit itself to the speed of infantry.

The principle of relative resistances does not in itself represent anything new in science: it was formulated long ago in mechanics, physics and the technical sciences where it is applied with great precision. But tektology makes this law universal, spreading it to all complexes, right up to psychic and logical systems; at the same time tektology must show how to utilize it in new and more complex applications. This science is consciously practical from the very beginning.

3. The Law of the Minimum in the Solution of Practical Problems

As with any scientific law, the law of relative resistances can be an expression of either the reign of nature over man or the power of man over nature. A building will fall if an inexperienced architect fails to harmonize its beams with the greatest pressure upon them; a dam protecting fields and houses from floods is, in the course of time, inescapably subjected to destructive breaks if the greatest possible rise of the water together with the most unfavourable combination of the force of its current and the wind are not taken into account; an enterprise will not survive if in its organization, unprofitable products, etc., are not taken into account. The famous trinity of the Russian national tektology– "perhaps, most likely, and somehow—" expresses nothing else but ignorance of the law of relative resistances; it is the result of the inadequacy and incoherence of organized experience, or that which is usually called "low culture." On the other hand, by systematically utilizing the law of relative resistance people can achieve the greatest stability in their own organizations and technical and ideological constructions, freeing themselves from the eternal threat of elemental forces.

The problems that ought to be systematically and consciously solved according to this law are innumerable and infinitely varied. The entire series of the most important methods which have long existed in practice and science, but which are not generalized, and,therefore,only partially applied to this or that sphere of labour experience, reduce to this law; beyond these limits, such problems are not only disregarded, but, in addition, are mastered with an unnecessary effort, due to lack of generalization and systematization.

In general, all problems which relate to the law of the minimum are of two types. To the first type belong those problems in which it is necessary to overcome *determinately changing* influences or resistances; to the second belong problems in which the magnitudes being overcome are *indeterminately changing.* Any building, machine or instrument can serve as an example of the first type: their different parts are subjected to the force of various pressures, frictions and blows, etc., but these differences can, in general, be expressed by definite coefficients, on the basis of experience and theoretical calculation. Examples of the second type are: a child who is being prepared to work and struggle in an uncertain, changing, and unforeseen social situation; an army in a defensive position on a temporarily established front line, while lacking objective facts determining the tactics of the enemy; a scientific or artistic work which is being exposed by the author to an unknown "public," etc. Problems of the first and second type are solved by two correspondingly different general methods.

The principal solution of problems of the first type outlines itself. If it is known that a given complex or a system must withstand influences at certain points or overcome opposition of a certain magnitude, then it becomes necessary to concentrate at these points activities-resistances of a corresponding character and of a requisite quantity. The whole difficulty consists in *knowing* the nature and magnitude of the activity that must be overcome and *having at one's disposal* sufficient activity against it. The first is achieved by collective *experience*, embodied in science, the second by collective *labour* providing the technical power over elemental energies of nature which makes it possible to exploit them.

It can be said that mankind is generally able to solve such problems. Builders and mechanics establish materials, forms and magnitude in various dimensions, various parts of a bridge, a house, machine, or a hand instrument by precise calculations. If the solution turns out to be unsuccessful, as it sometimes and not infrequently happens, then the fault does not lie in the method, but in other moments of the process: either the facts which had served as a basis for plans were imprecise, or error due to the imperfect nervous-psychic apparatus of people executing them crept into calculations, or new conditions arose which had not been observed before and, therefore, could not be taken into account. What the method has lacked so far is the perception of its universality and, therefore, of its universal formulation.

However, even this inadequacy is a matter of no small importance. People who skillfully and successfully utilize a given method in the solution of some technical problems, in essence simpler and easier, completely forget it or apply the method unconsciously, and therefore, badly, exactly where problems are more complex and difficult: for example, in socio-organizational acts, in pedagogy and in the creative arts, etc. Moreover, knowledge itself is uneconomically mastered when it is not adequately generalized: one and the same method each time requires special efforts for its mastery in various fields because it is apprehended as something different and new.

Here, for example, is the rule in war tactics: "the attacker has superiority." This is one of the innumerable special applications of the principle of relative resistances. The person who strikes the blow first chooses its place and time and, it goes without saying, concentrates his energies in so doing. When the first blow has been struck, the relative resistance at that point is already lowered; and if the attack continues, the chances of success are, of course, raised. French superiors who politely offered the first shot to Englishmen were clearly in error, if only because the killed Frenchmen could not in any way return the fire.

It is evident at once to a person who understands the rule of the "offensive" as a special conclusion from the universal principle that it also applies to any other struggle— economic, political, or ideological. Moreover, as experience shows, very often those individuals who while creating something original in these fields were unable to anticipate the inevitable struggle on its account, master the full practical meaning of the offensive after having experienced a sufficient number of blows.

The rule of *concentrated action*, different in appearance but essentially identical in application, reigns over the entire technology. Thus, the significance of the application of sharp instruments is due to the entire force of action being transferred to an extraordinarily small surface over whose stretch the sum of molecular cohesion is relatively smaller; for a blunt knife or an ax this surface is larger than for a sharp instrument, and this means that the sum of resistances which must be overcome is correspondingly greater. A blow is more advantageous than a single application of the blade because it concentrates its force during a short period of time. Assume that the resistance in question is 10 times greater than the activities per second which we have to overcome. It is then sufficient to apply the same force not in one second but in one fraction of a second, and the relative resistance during this time will not be 10, but only 10/20, or less than one; that is, the resistance will be overcome, and the contemplated destruction will occur.

The same significance lies behind the application of explosive substances. The energy of a chemical reaction, contained in a pound of dynamite, is not as great as is commonly assumed; it only slightly exceeds what is stored in a pound of coal. But if it is necessary, for example, to bring down a part of a rock, then by applying, say, a steam engine to break it, it would be necessary to burn perhaps hundreds of pounds of coal in order to obtain the immediate result which an explosion of one pound of dynamite will give. The energy of burning coal is distributed among numerous separate acts and over a relatively long period of time, whereas the entire chemical activity of dynamite is expended in an insignificantly small part of a second, in a single avalanche-like action; during this time the molecular couplings of the rock are broken and do not later restore themselves. But if the energy of the coal is concentrated in an act of similar brevity, then the coal will also exhibit the same formidable properties: this happens with the explosion of steam boilers.

It is easy to understand how imoortant the rule of concentrated action is in any ideological and cultural work; for example, in pedagogy, propaganda, or in the creative field, etc. But the workers in these fields generally arrive at an understanding and systematic application of this rule independently of each other by using their particular experience at the price of errors and failures. An inexperienced lecturer or propagandist tells his audience, usually with great competence, endeavouring not to omit anything, all that it must know; and the apprehending activities of the audience scatter in many directions, with the result that nothing is learned well; the productivity of the efforts of both turns out to be slight. The ancient rule, "non multa, sed multum" (not much, but well), appears here to be a suitable particular formulation of the principle of concentrated action, and scientific specialization with its positive progressive feature is obliged to the same tektological character:[1] the concentration of activities on a limited field of application in the cognitive struggle with nature.

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[1] It also has a negative feature, which will have to be explained later. For now, it is sufficient to point out that the rule of concentrated action serves in the solution of problems realting to a ***determinately changing*** environment, in which the concentrated allocation of activity is carried out in correspondence to its definite changes (or differences among its parts). For the ***indeterminately changing environment,*** as we already noted, the method of solution is different, and the first method is inadequate and unsuitable there, so that adaptations, in the form of specialization, produce in this case unfavourable results.

Problems of the second type are those in which the environment is indeterminately changing; hence the irregularity of its influences and resistances cannot be taken into account in advance. Of course, it is understood that the problem may be simply insoluble— namely, at a time when the indeterminate changes of the environment are not contained within some limits, sufficiently commensurable with the given means of solution; that is, the general stores of activities-resistances available for this purpose. For example, the problem of protecting the anthill against an assault of external foes is generally insoluble for ants, when the foes are such creatures as people; but the problem of a defense against an assault of other ants or insects is solvable. People, however, are capable of the collective creation of fortresses which can withstand any living enemies, but they are not as yet able to guard themselves against geological and, even less so,against cosmic crises. We must, therefore, study the question within the limits of its relative solution.

If any part of the system can be subjected to the influences of forces which cannot be taken into account in advance, then it is quite clear that any unevenness in the concentration of resistances for the benefit of some parts, and consequently to the detriment of others, is completely aimless. At the same time such unevenness is extremely dangerous, since it creates the probability of a destructive result from even relatively weak influences if they happen to act against the least firm part of the system. The maximum relative stability is here achieved by a ***uniform distribution of activities-resistances*** among all the threatened links of the whole.

The problem is solved generally in this sense— elementally by nature, and more or less consciously and systematically in the practice of mankind. The shell of a mollusk represents an approximately uniform protection for the surface of its body against mechanical and other influences; if in some places there are departures from this uniformity, this is a consequence of the solution of other special problems, since the problems of life in an organism are of necessity solved all at once, and naturally these solutions partly limit each other. Similarly, the threatened surface of a fortress is uniformly protected by its builders by not leaving weak points, as far as this is allowed by other vital conditions of the system; for example, when towns were fortified by walls, it was nevertheless necessary to erect gates in these walls for communication with the external world; but the forced weakening of the protective cover in these spots was made up by the efforts of guards, etc. The same also holds for the temporal chain of organizational relationships: if chances of an attack cannot be foreseen beforehand— the matter concerns, let us assume, a detachment of explorers passing through an unfamiliar country populated by wild tribes— then it is necessary to leave a continuous and uniform protection; its weakening, even for a short period of time, could turn out to be fatal, and a reinforcement without adequate information would mean a further expenditure of energy, whose conservation is so necessary under these conditions. When the calculation of the chances of obtaining food supplies over an indefinite period of time becomes too difficult, all the members of a collective are given a uniform ration, etc.

Evidently, questions of this kind generally arise when in a given system there is already a definite uneven distribution of activities-resistances among its parts or links which is harmful to the stability of the system in the indeterminately changing environment. Typically, such a situation is quite often created when a system which was formed under one set of conditions, in accordance with its various and definite influences, finds itself under another set of conditions whose correlations are quite different. For example, a cultured European who grew up in a city, occupied a high social position there, and developed his "abilities" accordingly, i.e., he has a definite distribution of the activities of his organism, finds himself in virgin steppes or wild forests. There, among innumerable unknown possibilities and dangers, his special knowledge, let us assume, of the textile business, mathematics, literature, or administrative technique, turns out to be not only useless but much worse: being attained by means of a special concentration of activities on the definite functions and organs, it is related to the unevenness of development which was possible and advantageous in a cultured social environment, but may turn out to be fatal in the lap of elemental nature, from whose blind activities he is no longer protected by the cultural-technical apparatus of society. The question arises in the form of a necessity for strenuous work of the most varied organs, when activities of the organism must be redistributed from the most hypertrophic to the less developed functions. Subsequently, to the extent that he is able to cope with the new situation, this environment will also be converted from indeterminately changing to a more and more determinately changing one: it is enough for him to build a hut, and the indeterminate changeability of temperature and humidity will be removed; once he tills a piece of land, conditions of nourishment will assume a more determinate character, etc. The organizational problem of his life will then also change its form, passing step by step to the type which we have considered first. It can be seen from this that between the two types are all the interval steps: more correctly, they combine continuously— in some respects, in the display of one group of activities the environment appears as determinately changing, in other aspects as indeterminately changing.

Let two hostile armies face each other. The one which seizes the initiative and goes first into attack must decide the question concerning determinately changing resistances. Naturally, the region of attack must become a region of the greatest opposition; the curvature of the front line by itself enlarges the surface of the contiguity of attacking units with the enemy; besides, these units emerge from shelters, which increases the relative force of the enemy influence, but the hostile army, of course, begins to concentrate, as far as possible, new units at points of the attack. Consequently, the first army must concentrate an adequate sum of its forces in this region, and in others it must maintain such numbers as may be necessary to resist possible counter maneuvers, to develop the outcome of a breakthrough, etc. If all of this is calculated well, and the relative opposition proves to be, where necessary, less than unity, then the problem is solved, and the enemy is partly or fully conquered.

If the enemy is only driven back and holds firmly to his positions, with the relative resistance equal to unity, then the problem appears in a new form. Here, there can be two cases. Either the forces are sufficient to attempt a repeated strike; it is then necessary to organize anew the decision of the same type as the first one but in a new situation; or the forces are exhausted, the reserves are small, and the army must give up the offensive for the time being; then, while the offensive is not contemplated by the enemy, the problem will be of the second type— the uniform consolidation of the front line and redistribution of forces in favour of the weaker parts of the front.

It is clear from these examples that (1) the solution of problems concerned with determinately changing resistances are tektologically more advantageous, since they correspond to a greater regularity; and (2) the transition to this type from the other may depend not only on the environment, whose influences become more and more determinate, but also on the active relationship of the system to this environment: by influencing the environment, a given system acts as if choosing its resistances.

The education of a child represents an extraordinarily important socio-organizational problem. This is essentially a process of introducing a new member into a social system. It prepares man for that living function, more correctly, for that sum of functions which is awaiting him in society. These functions, the conditions under which they will be performed, and the resistances with which they will have to deal, can in part be predetermined, and in part lie beyond the foresight of educators. Consequently, the conditions of the problem are twofold: on the one hand, the environment is determinately changing, on the other, indeterminately changing. The correlation of the two sides of the problem are different in different historical systems.

More ancient types of social organization are distinguished by the conservatism of everyday life: such are the primitive patrimonial communes from which the autocratic patrimonial and later feudal societies developed; to a significant extent the same peculiarity is preserved by the first feudal barter formations, such as the slave-ownership of various types, serfs, and even urban artisans. The conservatism of everyday life secures for children the social position and functions of their parents: the son of a military organizer or feudal lord must also become a leader of troops; the son of a dependent peasant, the same dependent farmer; the son of a smith, a smith, etc. Their social role is predetermined to the greatest extent, and the question of education is determined correspondingly: it develops the activities of a child in the image of his father or mother, in both domestic and corporate training. Pedagogical principles are very simple: all reduce to imitation or mechanical learning by heart, and later to special practical exercises; a special educational apparatus either does not yet exist or is in an embryonic stage. This is quite adequate as long as the social situation is stable: life stereotypically repeats from one generation to another the same technical and socio-organizational influences which are used to overcome the same resistances of elemental or human nature. However, if man finds himself in an unanticipated situation, he is in most cases powerless and helpless. If there is a change in general natural or social conditions, this lack of adaptability envelopes the entire life of the conservative collective. Thus, under the forced migrations of wild and barbaric tribes, the extinction of a significant part of such tribes was, at least initially, quite common. And extinction of backward nations, even during a peaceful contact with other civilizations, often appears even more vividly, sometimes making it difficult to perceive the direct causes of such an extinction. But the cause is basic and a general one: conservatively formed organisms are stable only in a conservative environment; when it changes, then it is inevitable that the relative resistances of some parts and functions of these organisms must from time to time turn out to be less than unity.

The replacement of conservative social structures by structures carrying the seeds of progressive development on the basis of contradictions— authoritarian by capitalistic structures— basically changes the conditions and problems of education. The tendency to preserve for children the social position and role of their parents becomes more and more limited, being increasingly paralyzed in practice by the elemental forces of social life; but even in those cases where this tendency is exhibited in reality, children are forced to fulfill their functions in a changed and continually changing social situation, i.e., they have to deal with resistances of a different magnitude, and partly of a different character. Stereotyped education in the image of the past then proves to be inadequate. Consequently, the problem of education must, to a great extent, be inevitably resolved under indeterminately changing conditions.

But the problem cannot be entirely reduced to this for the following reason. So far as the society of a contradictory progressive type lacks wholeness and is anarchical, a significant place in the relations of its elements belongs to strife and disingressions; in such a society, an individual retains his social position and function only by virtue of some definite and stable superiority over others. And such a superiority is, of course, nothing but the solution of a problem under conditions of determinately changing resistances. It inevitably means that this superiority also must be provided by education. But how?

In one of the previous illustrations we saw that the transition from the first, tektologically less advantageous type of problem to the second depends not only on the environment, but also on the active relationship to it of the opposing complex itself, in this case man: on his part the choice of the resistances is, of course, only possible to a certain extent and on a limited scale. Education can predetermine this choice in the form of specialization.

Indeed, specialization in this job or that, with its special materials and instruments, predetermines both the character and magnitude of those resistances with which man should have to deal, and permits him to harmonize most precisely and definitely the expenditures of his activities with the opposition from objects of labour, and helps him systematically to achieve the intended results. This is most evident in technology, or the organization of things; but the meaning of the specializing aspect of education is the same in the case of the organization of people and ideas. A specialist achieves growing results by unfolding a growing sum of energy in the struggle with resistances which he selects and which are more accessible to his calculation; it is this which forms the basic and stable superiority on which he leans to support his social role and position. The smith in his sphere of labour deals with determinately changing resistances of metals, fire, etc.; in this he surpasses other people: others who run into such resistances while, for example, using metal things which break, bend and are subject to damage, are forced to consider them as complexes of indeterminately changing resistances. But a sailor fully possesses similar superiority in the solution of another group of problems connected with resistances of the water environment, which for the smith and other people are indeterminately changing, etc.

Nevertheless, this is only one side of the educational problem: beyong the limits of his specialization, in all the remainder of his social and natural environment, man must somehow deal with the general problem of indeterminately changing conditions. To it corresponds another side of education which is directed to the development of organs and functions "in general," without reference to any previously contemplated special situation or particular goal. The greater part of what is called "physical education" and so-called "general education" enter here.

Of course, physical education also existed in conservative systems; but insofar as it did not concern itself with a predetermined social function of man, such as strengthening the muscles of the future warrior and hardening his body against foul weather and adversities on marches, it was not posited as a question of education. It was carried out elementally and "by itself," in the play of children and in the work of family and interfamily life. However, the society of a new contradictory progressive type was more consciously forced to bring out this side of general education as a special and important goal; exactly because it could be achieved "by itself" less and less under the conditions of growing social differentiation, with its inevitable consequence— the narrowing of the educational environment. It is sufficient to picture the extent to which the elemental-educational influence of nature is excluded in the situation of city children, even the children of ruling classes; the extent to which their physical health suffers from miasmas and air-dust in large modern centers; the extent of one-sidedness in the development of the bodies of children and juveniles working in factories, etc. And these disorderly formed organisms, weakened in many parts and functions, may have to face indefinite fluctuations in environments ranging from the accustomed situation of the workshop to the most capricious combinations of modern war on land, sea, or air! The question concerning the uniform strengthening of these organisms for all possible events is being more and more persistently advanced by life itself before social pedagogy, which already began sometime ago to work out methods for its solution, such as hygiene, athletics and others.

Of similar significance is the question concerning "general education, " i.e., the training of the nervous psychic system for undetermined possibilities. Let us assume that a man was born, lived and grew up in a capital where resistances against special and temporal orientation are reduced to a negligibly small magnitude by inscriptions on streets, numbers on houses, electrical clocks, etc.; and now he has to struggle, under war conditions with a detachment, through an unfamiliar terrain of forests, and swamps, in the midst of danger from people and the elements; in order to determine direction he is forced to use a pocket compass and a map; and if they are not available, to find his way according to the sun and stars, and with their aid also to tell the time; without some knowledge of geography and astronomy he would have been doomed to perish, and with him his companions. Or, for example, from a serene and quiet provicial life a man falls into a hurricane of the social elements of a revolutionary epoch with its unexpectedly changing current of destructive activities; how is he to withstand them, where does he direct his efforts in the absence of familiar objects? He would be fortunate if he could lean on general familiarity with history and the social sciences. These illustrations deal with comparatively extreme cases; but similar things happen at each step on a smaller scale; however, though these extreme events are encountered but once in the lives of the majority of people, to perish once is enough for anyone.

The definition of the pedagogical problem is not finished with the raising of the twofold question which is subordinated to the principle of relative resistances; in order to understand the next stage, we need to make one more step in the study of tektological regularities. For the time being, however, we are going to consider how far the solution of the problem is achieved in practice by a society which does not realize that this problem is an organizational one and which only vaguely takes into account its tektological experience.

First of all, a continual falling behind of educational materials and methods is revealed in relation to the changing conditions of social existence. Thus, long after the downfall of the authoritarian conservative bases of economic modes of life, the family of petty bourgeois, and even schools, have continued to educate children in the spirit of strict authoritarian discipline which kills initiative and criticism. However, such an upbringing, though suitable for the society in which men had to go through life according to predetermined paths, does much harm in the world of the anarchical struggle of all against all, with its changing directions and combinations of human forces; a world which requires that men, when necessary, reassess conditions objectively and act independently, not overlooking a moment. Life demands a continuous solution of the new problem of the second type, but the preparation is provided for the solution of obsolete problems of the first type.[1]

The second illustration is the stubborn preservation of ancient languages in secondary and post-secondary schools. The role of both lies in the preparation of organizers for social practice at various levels. For a definite epoch, a partial classicism was an important moment in the solution of problems concerning organizational specialization, inasmuch as it lay within the limits of certainty. Latin was the language of international intercourse, and of collective generalized "scientific" experience, which was predominantly organizational in nature. The development of new social relationships, such as barter and commercial capitalistic relationships, was at each step putting organizational classes, both old and new, before new situations and new contradictions and difficulties. In order to overcome them successfully, it was necessary to be guided by the entire social experience of the past— here Greek-Roman antiquity provided most of it— and of the present, where scientific acquisitions were also published in Latin. Therefore, the overcoming of the enormous mass of everyday resistances in organizational work depended on a knowledge of the ancient languages. But in the developed bourgeois world these conditions are not present, and an enormous amount of work, which was expended in colleges, gymnasiums, lyceums, and universities, etc., on learning ancient languages, ceased to be a means of solving real everyday problems: this entire mass of energy was diverted from the line of real resistances with which people would have to come in conflict.[2]

Also, the principle of relative resistances is very often violated in the teaching of modern foreign languages. Children of educated classes are very often taught from early childhood, while at home, and later at school, two or three foreign languages. This con-

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[1] Religious instruction in schools refers exactly to the outmoded authoritarian conservative pedagogy. Religion teaches people to regard life as predetermined by a higher power; each person fulfills a predestined role, meekly and submissively, i.e., without initiative and without criticism.

[2] In defense of the vestiges of the past, there are often advanced new substantiations and justifications; for example, the school classicism is defended under the guise that it facilitates the development of general logical abilities and the development of idealism in the child's soul, etc. There is no necessity to consider all such arguments: they would have had meaning if it were proved that the same positive results could not be achieved by other pedagogical methods actually preparing the organism for the conditions of his social and natural environment; only then could classicism be considered as an expensive but indispensable solution to the educational problem in its uncertain parts (i.e., referring to indeterminate changes in the environment).

sumes, in fact, a great deal of the free energy of their psychics. Are there many professions where as large a place is occupied by corresponding everyday resistances? Very few: diplomats, commercial and literary translators, in part sailors, and some groups of scientists. But parents and educators usually do not posit the question in this way; for them the matter is not at all concerned with the question of preparation for the forthcoming real resistances, but simply with the traditionally conditioned "education."

A similar absence of the organizational point of view is also usual in the matter of physical education. The organization of gymnastics and children's games rarely proceed, even today, from the question concerning the real processes of everyday struggle these or other applied methods may prepare the children for; and the choice in this sense is very often inexpedient. The hardening of the child's organism is, it would seem, a case of the most conscious application of the principle of relative resistances. Some parents who think it necessary to harden children against the cold, dress them up during cold weather much more lightly than they do themselves. But if, as it is natural to assume, children would dress up just as warmly as their parents do now when they grow up, then of what use will this raised level of hardening be to them? And it costs something to the organism, diverting a considerable quantity of blood to the skin membranes and leading to hypertrophy of the vessels. A characteristic of this is a widespread European custom, or stubborn fashion, of forcing children to play with bare calves when these parts of the body are well covered in the case of adults.

With the approach of sexual maturity, each child must face severe storms of the psycho-physiological spontaneity of his own organism which have a deep influence on his entire future life. But to this day there are few educators who would take the trouble to prepare the young child beforehand for the inevitable shocks.

One of the most curious illustrations of the ignorance of the law of relative resistances today occurs in the families of many intellectuals and idealists: their children's education is in the spirit of extreme "humanity," producing unusual gentleness and solicitude, removing from children, as far as possible, any suffering, any coarseness or cruelty of life. What can these hothouse plants put in opposition to the severe blows of actual reality? This almost predestines them to destruction.

As we see, the field of education alone provides many examples of the practical significance of the principle under consideration, of how it painfully rules over people when they lack a conscious mastery over it.

The explanatory significance of the law of relative resistances is particularly precious for our times. This law alone is able to settle the whole series of the painful cultural puzzles of our time which almost undermine all faith in the development of the social qualities of humanity which constitute the basic meaning of civilization.

Herds of millions of people, belonging to the most civilized nations and the most advanced classes, rushed before our eyes to destroy each other with the same zoological fierceness as did their far distant animal-like ancestors. London and Paris, great centers of world culture, were conducting the same wild and patriotic pogroms as the semi-Asiatic Moscow. Armies of the most advanced nations committed as monstrous cruelties as Kurds or Cossacks, Ingushes or Morrocans. The gentleman-officers of free England together with the generals of tsarist-despotic Russia shot Russian revolutionary prisoners of war. Not only the priests of outmoded religions, but also higher intelligentsia, poets, artists, even people of science, proudly marched at the head of universal brutality, etc. Does this not mean that there only exists the progress of technology and the external forms of life, but not of human nature; is it sufficient for a whirlwind to tear off from the European his paper coat of humane civilization in order to reveal an age-old troglodyte?

In reality this is not so, and an explanation of the contradictions which bewilder the eye is provided by the law of the least advantageous conditions.

Modern capitalistic society is most heterogeneous in structure, and represents, in the words of one German professor, a "gradation of the most varied existences." Besides, the lower levels in the development of social qualities are distinguished in various countries much less than the middle and higher levels; differences of small magnitudes, naturally, cannot be great: a London hooligan from the bourgeois classes or the corresponding type in the Russian capitals and an ignorant savage are approximately equal in their ability and inclination toward destructive acts. Let us assume, that in London from among the 6 million inhabitants, there is only 1% of these hooligans, i.e., 60 thousands of the elements in question; whenever a social catastrophe provides them with a slogan and a possibility of unification for one moment, they are able to carry out a cruel pogrom, for example, against all Germans in London. It is possible that in Moscow, from among the 2 million inhabitants, 90% of them are at the same level, i.e., one million and eight hundred thousand; under similar conditions they produce the same pogrom, but the magnitude of destruction is not greater, because its object is not greater than in the previous example. An enormous inequality in culture will be concealed by the equality of the lower complexes of a cultural system.

This is not all. Contemporary cultural man, taken in isolation, is also a heterogeneous whole. His psychomotor system also contains a gradation of inclinations, from the lowest to the highest, from the animal instincts of his cave ancestor to pure social idealism in its various forms peculiar to different classes. And again when an external influence of a sufficient force, directed at the lower complexes of the psychomotor system, overcomes their inertia and upsets their equilibrium, two men may exhibit equal elemental destruction, although in the psychics of one the lower group of reactions constitutes, perhaps, one-tenth, and in the psychics of the other, nine-tenth of the whole.

Such "equalization according to the lowest" emerges especially vividly in the herd actions and emotions of the crowd. A crowd is a collection of individuals related, on the basis of physical proximity, by direct imitation. And its action is concentrated on those groups of psychic reactions which are most common to all; but such are exactly the lower groups; higher groups, with their complex differentiation, diverge much more. Therefore, in a crowd the man who has preserved but a small remnant of zoological inheritance in his psychics may commit the same brutalities as another in whom this inheritance predominates over social qualities; and a courageous man who under normal stimulation of higher complexes of his psychics fearlessly looks in the eyes of death, may yield to a panic-fear just like a weak coward, etc.

The law of the least advantageous conditions will sternly rule over man for as long as he does not gain mastery over it. There is a problem for tektology here, which is how to master the law in the cultural sphere in order to avoid equalization according to the lowest common denominator, which subordinates our civilization to the vestiges of savagery, although these vestiges may be much weaker quantitatively than the activities accumulated by civilization. This is a question concerning the organizational transition from the lower to middle magnitudes, and its fundamental solution requires still another step in tektological investigation; formulas of the minimum are insufficient here.[1]

4. Compact and Diffused Structures

The structural stability of any system can also be considered from another point of view. The systemic environment and the system directly influence each other only where the two come into contact, in the "frontier region," understanding these words tektologically and not only spatially. The magnitude of the frontier region, or the number of contiguous points, may be increasing or decreasing. For example, when a tortoise draws in its head and paws, or a man "shrinks," this quantity becomes lesser; a political organization grows when it sends out agents and agitators to places or social circles where they had not been previously; this is also true in the case of a scientific theory which embraces new groups of facts, etc. Two complexes and two systems that are similar and equal in all other respects may differ precisely in this. How can such changes or distinctions affect structural stability?

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[1]See Tektology, Part II, pp. 72-86; and Chapter VI of the Essays.

Here is one of the simplest cases. Two pivots of equal length, say one meter in length, are made from two equal quantities of metal, but one of them is of a uniform thickness along its entire length and the other of a "diffused form," with successive contractions and expansions. The properties of the first and the second will turn out to be different in whole series of cases. The resistance to breaking is lower in the diffused pivot; if the environment is such that it oxidizes them, then it will also rust faster. In a cold environment it will lose heat faster; but in a warm environment it will also acquire heat faster. Its static electrical capacity is greater, the resistance to current is more significant, etc. All these are consequences of an enlarged surface, a greater sum of contacts with the environment.

It is evidently immaterial whether the matter concerns a physical surface, as in this case, or other contacts with the environment; the more of them there are the lesser is the concentration, on average, of activities-resistances per unit at such a "frontier region;" and besides, in diffused forms this concentration is also uneven and represents more fluctuations from one point to another. Consequently, according to the law of relative resistances, the destruction of connections in these forms, or their disorganization, is easier to accomplish.

This can be expressed more generally as follows: negative selection manifests itself more intensively in "diffused" forms. For example, the cooling of the pivot represents a negative selection of its heat activities; it occurs faster in the case of a diffused pivot than in the case of an even one.

A structure which is more even and branches out less is generally opposite to a "diffused" structure; we will denote it by the term "compactness."

Thus, in the case of more compact complexes, negative selection is less intensive. And positive selection? It is evident that positive selection is also less intensive. Where temperature rises, i.e., where heat energy is being more assimilated than disassimilated, a diffused pivot will acquire more heat energy during the same period of time. Through a greater number of contacts with the environment, assimilation from the diffused pivot is correspondingly greater.

Hence, a general solution to the question of which structure is more favourable for the preservation and development of complexes is as follows: ***under negative selection a compact structure is more favourable, under positive, a diffused structure.***

This is known both to the tortoise which pulls in its extremities under conditions which it considers to be negative, and to the man who shrinks in the cold... But the scientific, tektological formulation makes it possible to obtain a simple solution to many organizational problems which appear to be complex and difficult in normal situations. The question concerning the advantages of a "centralist," or "federal" type of organization under different conditions can serve as an example.

Of these two types, the centralist, i.e., the system which is characterized by the presence of a center on which all other parts of the system depend, and to which they are closely coupled and subordinated, is more compact; the federal type of organization with a weaker coupling of its relatively autonomous parts represents the case of diffused forms. For example, tsarist Russia and bureaucratically republican France were centralist; pre-war England, the United States and Switzerland were federal in comparison to them. The strengthening of power in a party of the ruling center expresses a tendency toward compactness; strengthening of the autonomy of the local and special organizations, toward diffusion; a religious sect with a definite and strict dogma, which is shared by all, is more compact than a scientific or philosophical school, which incorporates various shades or currents, etc. These characteristics and our general formula are sufficient in order to be convinced that a "federal" structure is more advantageous under favourable living conditions and the operation of positive selections, and a "centralist" structure under unfavourable conditions when selection is negative. In the first case, the autonomy of the parts permits them to unfold better, to develop more freely, and to utilize more fully the inflow of energy supplied by the social and natural environment; in the second case, the couplings are more solid and tighter, and as a result they endure longer against destructive influences. This can be illustrated by innumerable examples.

The governmental structure of Switzerland, the United States, and England with her wide local self-government and external colonial federal couplings, was possible only because of exceptionally favourable living conditions, into which they were put by historical fate. On the other hand, states which developed during long and fierce wars, and which were surrounded by enemies, could exist only on the centralist basis; such were the eastern despotisms, Russia and France. The same correlations are revealed in political parties: difficult external conditions are endured more easily under a more compact structure; for example, a division into factions at such times is particularly harmful, as is evidenced by the experience of the Russian parties during the period of reaction. With a particular worsening of the situation, the couplings of central and local organizations expressing a "diffused" aspect of party structure, inevitably broke up, and the party was converted into a series of practically uncoordinated groups. If a unity was maintained, it was only because of the unity of program or dogma, which then was so much stricter; this is also a compact type, but of a different kind; namely, it is an ideologically compact complex. Illustrations from psychology provide those states which Aristotle called "macropsyche" and "micropsyche," the widening and narrowing of the soul. Pleasant, happy sensations, which correspond to a higher inflow of energy into the nervo-psychic system, dispose one to expand one's intercourse with tne environment, to intensify the activities of external senses to increase mobility, to raise "sympathetic" tendencies, etc. On the contrary, painful sensations expressing negative selection call for a "rolling up" of the soul, a weakening of attention to the surrounding environment, a weakening of the entire receptive activity, a lowering of intercourse with other people, a yearning for peace, etc. Thus, the adapting organism passes from the more diffused correlations to the more compact ones and back; the psyche of man functions according to the same law as does the body of a tortoise.

The terms "diffused" and "compact" form are adopted conditionally by us because better terms could not be found. Their inadequacies are not limited by the fact that they suggest a picture of a physical structure when the matter concerns any organizational combination. But even for physical complexes, "diffusion" and "compactness" do not necessarily correspond to those concrete forms which are involuntarily summoned by these words. The question concerns, it should be remembered, the relative quantity of contacts with the environment, and nothing else. If we compare two cylindrical pivots of identical volume and identically even surface along their entire stretch, without any expansions and contractions, there may still be the same difference between them. The one is, for example, shorter and thicker, the other longer and thinner; then the surface of the first is smaller, that of the second larger, and the second will reveal, in comparison with the first, all the "diffused" properties: it breaks more easily, heats and cools faster, rusts faster, etc. But if the cylinder is shortened and thickened until it acquires the form of a disc, then the "diffused" properties will also appear in it. The greatest compactness presents a sphere which is homogeneous in its internal structure.

This means that diffusion is generally characterized by *uneven couplings in the various parts of a complex or in various directions*; the greater is their uniformity, the greater their "compactness."

It is interesting and important to note that these concepts are fully applicable not only to spatial but also to temporal structural relationships.

Thus, many complexes of activities change in time in a wave-like fashion, as if by expansion and contraction. All fluctuating processes, such as psychic, organic, molecular and etheric processes, can be presented in the form of flows which at one moment expand, at another contract in their paths; representing this graphically, we will evidently get diffused forms. And all the conclusions about these forms will remain in force. For example, if two waves of identical nature are compared, such as etheric light waves, then from the two the diffused character is evidently more sharply expressed in shorter waves. Once having arisen in the universal environment, all waves are, in some way or another, absorbed by its various complexes, by matter, plants, and perhaps even by the ether itself; consequently, the waves are under negative selection. And it follows that less diffused forms are more favourable for their stability, i.e., the waves whose length is longer. And indeed, the shorter the vibrations, the easier they are absorbed by the smallest opaque particles; longer vibrations, as if skirting around these particles in conformity with the laws of so-called diffraction, are not absorbed. Inasmuch as there is a partial absorption of the energy of the rays, because of the incomplete transparency of the environment, violet rays, being the shortest of all the visible waves, must weaken in comparison with others, especially the red waves. This is presently accepted by the physical theory; spectral analysis, apparently, also supports this: in the spectrum of the farthest stars violet rays are correspondingly weakened, as its comparison with the spectrum of the closer stars of the same type shows.[1]

The life of our organism also flows according to a type of vibrations: during the day our organism develops more activities than at night, during summer more than in winter; it experiences a series of expansions and contractions. In the life of mankind, as a whole, positive selection generally predominates: it is growing and its forces are increasing. Under such conditions, diffusion in time ought to be advantageous for mankind; and indeed, by lowering the efforts of the organism during the night, a greater intensity of work is achieved during the day; the greater the amplitude of this fluctuation, the higher is the daily intensity of work, and the more easily can people overcome the resistances of nature. But if the organism finds itself under the conditions of negative selection, such as in chronic malnutrition, then the correlation will be different: the greater the amplitude of the 24-hour fluctuation, i.e., the more intensive is the day life of the organism, the less it can endure; and a Russian peasant, for whom this amplitude is lower, will endure, other conditions being equal, less than an English worker.

Here, as in many other cases, the organizational properties of time do not differ from those which are revealed in space.

It is necessary to note that the question concerning a diffused or compact structure was considered in relation to an *indeterminate* environment, under conditions of both positive and negative selection *in general*, taking into account various and changing influences which were not especially concentrated on those or other parts of a complex. However, where there is such a stable concentration of external activities or resistances, the problem deals, of course, with determinately changing conditions, and the question is not reduced here to simply a larger or smaller quantity of connections. If, for example, negative selection manifests itself most strongly at one part of the system, then it is advantageous to have this part better developed for the preservation of the whole, i.e., under negative selection it also turns out that a definite *irregularity* of couplings is more advantageous. Thus,

[1]Previous facts regarding this are being currently disputed, but the question here concerns only the magnitude of the coefficients of absorption, and not its nature.

in all machines, parts which are subjected to increased friction, pressure, bending, and stretching are made either more massive, or from a more solid material, i.e., tektologically more connected material; and this, of course, imparts a more diffused character to the entire complex; regularity, however, would have been disadvantageous. But this only means that definite and special correlations always limit and modify the application of general schemes which express indefinite correlations.

5. Systems of Equilibrium

The "law of equilibrium," formulated by Le Chatelier for physical and chemical systems, but in reality tektological, or universal, is an expression of structural stability.

A system of equilibrium will be called such if it maintains a given structure in a given environment. A common illustration is scales in a position of rest. If pressure is applied to one scale, if, for example, a weight is put on it, then this scale will begin to drop and the other to rise, and the arm will change its position from a horizontal to an inclined position: this is a structural change. But as this change occurs, a counteracting force appears in the system itself: the scale with the weight falls down with a decreasing speed, but only to a certain limit beyond which there begins a movement in the opposite direction, and after a number of fluctuations there is established a new equilibrium, which is determined by simple mechanical conditions.

A more complex illustration is that of water and ice in the same vessel under 0° Centigrade, i.e., under the temperature of freezing and thawing. If the vessel is heated, then part of the ice will absorb the inflow of heat energy and turn into water, thus counteracting the rise in temperature: the temperature of the mixture is maintained at the previous level until all the ice is thawed. But if, instead of heating, the same mixture is subjected to a higher pressure, then part of the ice, turning again into water of a lesser volume, thereby counteracts the rise of pressure inside the mixture. A mixture of liquid and hard mercury when heated also reacts by melting which counteracts the change in temperature; but when the pressure is raised, the reaction is opposite— part of the mercury freezes. Why? Because mercury, similar to a great majority of bodies, takes up a lesser volume in a hard form than in a liquid form; consequently, the mixture counteracts the increase in pressure not by thawing but by freezing the mercury; and this is exactly what happens. Water, as an exception, presents opposite relationships of volume; therefore, the same counteraction is achieved in the opposite way.[1] If a constant current circulates in an electrical conductor,

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[1]The exceptional properties of water are explained by the fact that the liquid water is not a simple chemical combination, but a solution of ice changing in proportions with changes in temperature and pressure, and subordinated, consequently, to the law of solutions.

then any change in this current calls forth so-called self-induction which is contrarily directed to this change, thus diminishing it, etc.

The law of Le Chatelier is formulated as follows: *if a system of equilibrium is subjected to an influence changing any of its conditions of equilibrium, then processes appear in it which are directed to counteract such changes.*

It has been known for some time from experience that this law is operative not only in physical and chemical systems, but also in many others. Thus, living organisms under normal conditions react to external influences in a similar way. If the human body is subjected to cooling, oxidizing and other chemical processes immediately begin to intensify and develop warmth in it; if it is heated from outside, then perspiration with evaporation, which absorbs heat, is raised. The role of "shrinking" from cold, which decreases the surface area of cooling, is the same; and when the tortoise draws into its shield, under all kinds of unfavourable influences, this again is a decrease in the surface of an external influence. As an external irritation increases, according to the law of Weber-Fechner, sensation does not grow to the same degree, but only proportionally to its logarithm, i.e., comparatively slower and slower;[1] this means that along with the force of external irritation, resistance to it quickly grows, so that the smallest amount of energy of the strongest irritations reaches the nerve centers; otherwise these centres, with their fine sensitivity which depends on tender structure, would have been quickly destroyed. Thus, our sight still perceives the light of a star of the sixth magnitude; but the light irritation from the sun is approximately four million millions times greater; what brain could directly endure such differences in the strength of influences?

It is possible to show, by a simple analysis, that the law of equilibrium is applicable to any system which preserves its given structure in a given environment. Let us begin with a comparatively simple and quite typical example: the system of "water and ice under 0° Centigrade." Let it be subjected to heating. According to contemporary scientific symbolism, this means that fluctuations of molecules in the surrounding environment become more energetic, and their blows, which are transmitted to the molecules of water and ice, become stronger. This energy of the motion of particles, expressed by their "temperature," is an activity of the same order as that of their coupling, capable of conjugating with it, and paralyzing it. This is the way it actually happens here.

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[1]In other words, if the first increases in geometrical progression, for example, 1:2:4:8:16:32, etc., the second, in arithmetic, for example, 1:2:3:4:5:6. The correlation is approximate only.

The heated molecules of water transmit the excess of their energy of motion to the frontier molecules of ice with their intensified blows. This excess is paralyzed by the coupling activities of ice, until equality with them is reached; and then there occurs a full disingression, which, as we know, results in the breach of connections: the surface particles of ice tear away and pass into the mass of liquid water. The entire excess thermal energy, acquired by the particle until that moment, was used in the struggle with the coupling activities in order to paralyze them; therefore, the kinetic energy of the particle itself turns out to be no greater than it was before, and is measured as before by the temperature of 0°. The same thing occurs with other particles of ice. Thus, with the heating of the total mass of water, the former level of 0° is maintained in the frontier region of ice, counteracting this heating until all the ice disappears.

If the question does not concern heating but the rise in pressure, this means that the kinetic energy of particles of the surrounding environment does not, on average, increase for each particle, but the number of their strikes, which operate in the frontier region of a given system, increases. And here, the rising activities of pressure are transmitted from particle to particle inside the system. These activities increase the frequency of collision among particles, thereby aiming to limit the amplitude of their notion. And again, this inflow of activities can conjugate and enter into disingression with couplings of the ice molecules; under disingression they are, as in the other case, torn away and joined to the liquid, and the pressure is reduced because the volume of water is less than that of the ice.

But, as was already mentioned, water is an exception. If another similar system is considered, such as "solid and liquid mercury," then the opposite effect is observed. Adtional activities of pressure enter into disingression not with the couplings of particles of the solid body of the system, but with the activities which counteract the couplings in the liquid. The pressure lessons the amplitude of motion of liquid particles, so that this amplitude becomes less than the distance between particles, and they now fluctuate without entering one behind the other and without intermingling, but keep around a middle position: the particles of a solid body move exactly in this way. Some part of the liquid freezes up; with this its volume, however, becomes smaller; as in the previous case of the thawing ice, this reduces the pressure.

Why do activities of one type— the force of pressure— in two different cases paralyze through disingression, not identical, but quite opposite activities, as if *selecting* those which are prescribed by the law of Le Chatelier? The matter lies precisely in a choice, not a conscious one, of course, but an *elemental choice*.

Molecular movements are presented by scientific theory in the form of innumerable and variously directed "infinitely small" activities. If into a system new activities enter from outside, then it is evidently necessary to accept all sorts of combinations created by them and the former activities, all sorts of collisions, conjunctions and disingressions. But from among these combinations some will be stable, others unstable; the first will be retained, the second removed by selection.

Thus, in the system of "water and ice," activities of external pressure must enter into disingressions partly with the movement of molecules of the liquid, transferring them into a solid condition, and partly with the couplings of ice molecules, thus melting the ice. But since ice takes up a greater volume than water, from which it is derived, the pressure will increase in cases of the first kind, but will decrease in cases of the second kind. The question is which of these changes turns out to be more stable?

The answer depends on the structure of the system in which these processes go on; until the structure is unknown, neither possibility is excluded. But it is necessary to recall that identical processes took place in the system before the entry of new activities: individual particles of water were converted into ice, thus increasing internal pressure, and individual particles of ice were converted into water, decreasing pressure. If one or the other of these changes were more stable, then the entire system would not have been a system of equilibrium; its structure would have been continually transformed, in the first case in one direction, in the second case in another. But this did not occur: those changes which crossed a definite border immediately turned out to be less stable and were removed by selection. The structure of systems of equilibrium, for contemporary scientific thought, is characterized precisely by their containing opposite processes which neutralize each other at a certain level. The matter is presented so that, at this level, the tensions of oppositely directed activities are equal; when, however, one of the two processes is intensified and rises above this level, the tension of corresponding activities becomes more significant, and the flow of these activities is directed in an opposite direction, as in the case of water, which having risen above its middle level, then falls downward. In this way equilibrium is maintained, and with it the stability of the system under normal conditions.

Now it is possible to consider in advance what will happen when the activities of pressure in various conjunctions and disingressions entering from outside condition the conversion of some particles of water into ice and some particles of ice into water. Changes of the first kind, increasing pressure, create a new difference in tensions which directs the flow of activities into an opposite direction; consequently, these changes are unstable and are removed by selection. Changes of the second kind, decreasing pressure, which is already raised above the middle level, reduce the difference in tensions and do not call for the opposite flow of activities; therefore, they are more stable than the first and selection is more favourable for them. The result precisely corresponds to the law of Le Chatelier: the process which diminishes the effect of an external influence is revealed as if counteracting such an influence.

In the example with the solid and liquid mercury, on the contrary, the transition of solid into liquid particles increases pressure, and the transition of liquid into solid particles decreases it. Therefore, under external pressure, processes of the first kind, increasing the difference in tensions, will be less stable; processes, however, of the second kind, decreasing this difference will be more stable. The general result of selection is opposite to the previous one, again in conformity with the law of Le Chatelier. And the same evidently ought to be the case with any system of equilibrium, no matter what activities enter into its composition and no matter what opposite processes neutralize each other within it. For example, in our organism there are processes which continuously free and absorb heat in approximate equilibrium in relation to a given environment; if the environment changes in the direction of heating, then the processes which absorb heat are intensified; if in the direction of cooling, then the opposite, heat generating processes are intensified.

But all of this refers to *systems of equilibrium*. In systems of disequilibrium the matter stands quite differently. If changes simultaneously go on in them in opposite directions, then one of the two groups of changes is more stable, and therefore, the whole is transformed step by step into its direction. What results are obtained with an external influence on such complexes?

A mixture of hydrogen and oxygen can serve as an illustration; this is also called detonating gas. Under normal temperature, this mixture appears to form a completely balanced system; no methods presently available can directly discover the ongoing chemical changes in it. In fact, however, such changes are present: the mixture is transformed into a water-steam, i.e., the processes of conjunction of hydrogen with oxygen preponderate over the opposite ones. But the reaction proceeds so slowly here that its completion takes— according to approximate calculations which are based on the observation of the process under high temperatures and the formula for changes in speed of reactions by Van-Goff— hundreds of billions of years. This is a system of *false equilibrium*, as it is called; it is not chemically and thermally balanced because heat is being discharged during the reaction, and the mixture must, though imperceptibly, heat itself.

Let an external influence be applied to it, such as the raising of its temperature. Internal changes of the complex in this direction were already more stable than the opposite ones; the same also holds for the newly added changes. Not only is there an absence of counteraction to them, but the process of conjunction of hydrogen with oxygen is also speeded up, causing an even greater heating of the mixture; this is exactly contrary to what happens with systems of equilibrium. With close to normal temperatures, this is again an insignificant and imperceptible magnitude; at approximately 600° Centigrade, it becomes so great that it quickens the process to a level of explosion, which in turn produces heat of several thousand degrees.[1] Tektologically, this explosion, however, is not something new; it is a continuation of the process which went on before; only its tempo has been altered.

Such is "false equilibrium." Two facts are consequently understood by these words: (1) when equilibrium is continually disturbed in a definite direction, the complex is in a process of transformation; and (2) we do not directly notice this because of the imperfection of our organs of perception and methods of observation. When, however, we talk about a "true equilibrium," it does not mean a complete equilibrium, but only a tendency to it with two-sided fluctuations. If a crystal of salt happens to be in a saturated solution, then this is a "true equilibrium," just as water and ice are in equilibrium at 0° Centigrade. Between the dissolution of salt particles and the deposit of others from the solution, and between the thawing of ice and freezing of water, there is not a precise equality at any given moment; but if the first process now preponderates, and a departure from the level turns out to be in one direction, then at the next moment the preponderance will pass to the second process, and the fluctuation will be turned into another direction, etc.

The distinction between systems of equilibrium in this sense and those of disequilibrium, and especially the systems of "false equilibrium," has tremendous significance not only in cognition but also in the practical affairs of life. It is extremely important to *differentiate* one type from another in order to foresee correctly the possibilities which face this or that system. And this is especially important where the law of equilibrium has not yet been precisely formulated and used systematically; that is, in the realm of complex vital, psychic and social phenomena. This can be illustrated by means of examples.

If a herbivorous Greek tortoise is lightly struck, it immediately hides its head, paws, and tail in its box. The surface accessible to hostile forces is thereby decreased and, consequently, also the direct action of these forces; this is in complete conformity with the law of Le Chatelier. It means, therefore, that the organism of the tortoise corresponds to systems of equilibrium in the nature of its psycho-motor reaction, it tends to stability and is conservative. One cannot, therefore, expect from the tortoise, for example, a progressive development of its activities and an agressive conquest of the surrounding environment, something which organisms of another type are capable of doing.

Let us assume, that the tortoise behaves differently; it answers external violence by

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[1] Exactly under these temperatures hydrogen, oxygen and water-steam now create a real system of equilibrium in which the reaction of coupling is neutralized parallel with the ongoing reactions of decomposition. Under 3000° Centigrade, such a combination is composed 88% of detonating gas and 12% of water-steam.

blows of its paws or jaws. According to the usual usage of the words, this is a real "counteraction;" but it would be the greatest mistake to see in this a conformity to the law of equilibrium: this is something quite different, and it is necessary here from the very start to remove verbal confusion. By "counteracting" opposite movements, the tortoise would not have *directly* decreased but increased that difference in mechanical tensions on which the direct result of the external influence depends; only with subsequent consequences, such as the destruction or flight of the enemy, could this have led to a real decrease of harmful activity; but it could have also led, when the enemy is stronger, to the opposite effect. A well known bear trap is based on this— a log, which is so suspended as to prevent the bear from reaching the beehive, oscillates like a pendulum. The bear pushes it away one time after another, and receives blows of an increasing force, i.e., the growth of mechanical difference is being maintained and accumulated. In the law of Le Chatelier, the concern is with internal processes of the system and the internal regroupings of its activities which *directly* reduce the result of an external influence. The acts of struggle against the cause or carrier of this influence are not, therefore, appropriate; and they indicate that the matter here is not concerned with a system of equilibrium.

As already mentioned, the human organism reacts to an increased heating from outside by an increased evaporation of water, during which heat is absorbed; this is fully consistent with the principle of Le Chatelier and shows that the organism represents a system of equilibrium in terms of direct thermal relationships with its environment. But frequently, other nervo-muscular acts simultaneously appear with such a reaction: a man begins to fan himself, open windows, etc. These movements are accompanied by a transformation of chemical and physical energy into heat and, consequently, in themselves, i.e., taken independently from further results, lead to still greater heating of the body tissues. Hence it is clear that the complex is unbalanced in relation to the motor and nervo-muscular activities of the organism. And it is necessary to remember that, generally, one and the same system can always be, from the standpoint of some activities which enter its composition, a system of equilibrium, and others, a visibly or latently unbalanced system. Thus, the same detonating gas, which represents under low temperatures a chemically false equilibrium, can be considered, in a mechanical sense, as being in a true equilibrium; it reacts to an increased pressure by an increase in density, and vice versa.

Let us consider the following case: a man is plagued by unfavourable influences of the environment, such as injuries, oppression, losses, and various blows of fate. How will he react to all of this? Two basic types can be observed here.

Tendencies to self-limitation appear in some natures: patience, submission, humility; often also curtailment of wants ("ascetism"), and even the curtailment of intercourse with other people ("the life of a hermit"). What is the meaning of these reactions? The external environment decreases the vital activities of the psychic system by its hostile forces; and this system narrows down its active manifestations, the region of its contacts with the external environment; thus, the sum of the unfavourable influences of the environment is directly reduced, as was the case in our example with the tortoise. Obviously, the principle of Le Chatelier appears here; this is a system of a balanced type.

Other natures put on a fighting stance is relation to the environment, struggle energetically against its hostile forces, and thus broaden their active manifestations and increase their tension. Losses of energy, which are brought about by negative influences from outside, are increased by additional new expenditures on struggle; and the sum of contacts with the external environment, the depth of penetration into it, generally that what can be called "vulnerable surface," grows still further. This is exactly contrary to the principle of Le Chatelier, and points to a complex of an unbalanced type.

It is clear that the natures of the first kind are incapable of practical progress, the development of their forces, or victory over the environment; the natures of the second type are capable of either development to progressive victories over external forces, or to degradation through defeats; both often intermingle in various proportions; for example, an artist's creative development is often connected with a destructive dissipation of life; even more often one type is replaced by the other: a disequilibrium of progress by a disequilibrium of regress, when, for example, the environment changes in a sharply unfavourable direction; but an opposite shift is also possible. But natures tending to equilibrium, being incapable of *developing* resistance to their environment, naturally pass with exhaustion of resistance into degradation.

In the Russian language there is a special word for denoting this type, namely, "the man in the street." Popular consciousness, which develops languages in its elemental collectivisim, frequently expresses a deep experience which escapes even the consciousness of a well-developed individual. The concept of "a man in the street" contains an image of existence which *fluctuates around* a certain level. The character of a man in the street means exactly an absence of fighting reaction to the influences of the environment; it consists in patience, submission, and internal softenings of the blows from outside.

But, it should again be remembered that all tektological determinations are relative. A man, tending to equilibrium in some fields of his life, may be positively or negatively unbalanced in others: a "citizen," even a "revolutionary" in political life, may be "a man in the street" in his family relationships; or, for example, a man in the street in all his contacts with society, may be a petty tyrant in his own business, etc.

The preponderance of these or other psychic types depends on social conditions— on the structure of society and on the direction and tempo of its development as a whole and in its separate groups and classes. Tendencies in social ideologies are also reflected in a way that corresponds to these types. And inasmuch as the pinnacle of each ideology, its highest characteristic, lies in the *vital ideal*, a tendency to one or to the other type appears in it especially vividly. The tendency of a collective to equivilibrium is embodied in the ideals of passivity and indifference; the purest and the most perfect of them all is the "nirvana" of Buddhists, an absolute equilibrium of the soul, its complete calm in which it is unperturbed by anything, other than the contemplation of eternity. Here, too, belong ideals and dreams; such is the Christian ideal, with its image of justice in the other world, of reward for the suffering, humble and submissive, of punishment for the wicked and proud; and both the reward and punishment are not realized by the efforts of people themselves, but by a deity, a higher universal activity who restores a disturbed equilibrium in the life here on earth. Day-dreams are similarly one of the psychic reactions to the hostile influences of the environment; it is a reaction of "self-consolation" which corresponds fully to the principle of Le Chatelier: an internal counteraction of psychics to that pain which is caused by destructive external forces.

The other group contains socially practical and actively organizational ideals. Such is, in the highest degree, the ideal of a labour collective.

Societies, groups and classes which are vitally hardened in their settled forms or which are already losing their position and are unable to defend it successfully, belong to the first group; growing collectives, conquering elemental and social resistances, belong to the second group.

Systems of equilibrium may pass through structural changes, which are often imperceptible to direct observation, into systems of disequilibrium, and vice versa. These transitions are very important in practice; they can best be captured after a change in systemic reactions has taken place. In the case of the interrelationships among people and organizations, correct evaluations of the tendencies of both kinds, especially their replacement, can provide safeguards against the greatest and irreparable mistakes. Such evaluations are, in fact, being continuously made by people on the basis of "common sense," i.e., the common tektology of the man on the street. From the few observations of the reactions of a man to these or other external influences, conclusions are usually drawn about his general constitution, whether it is stagnant, tending to equilibrium, or, on the contrary, full of initiative and impetuously militant; and these determine subsequent relationships to him.[1] Popular tek-

[1]Thus, during the time of underground work, organizers-recruiters of the revolutionary parties, divided the entire human material into "active" and "non-active;" the latter, of course, were at once eliminated from consideration.

tology has also noticed the types of false equilibria, as is evidenced by such proverbs as "still waters run deep." However, this vague, imprecise and unstable experience was not subjected to scientific treatment, and each man had to master and formulate it for himself.

Even more important is the ability to recognize both types in the relations between organizations— state, party, economic, cultural and military— in the creation of cooperation between them and in plans for a victory in the case of struggle. Here the inadequacy of "practical wisdom" possessed by organizations or their leaders may lead to tragic consequences.

Let us assume there is an army which reacts to an enemy attack by reducing its front line and passing to more defensive positions, instead of making offensive contra-maneuvers: it has an appearance of a system tending to equilibrium. However, this may not be its real tendency, but only a camouflage; then the real condition of the army can be captured in displays of its "spirit" and in the character of partial outbursts of its "activities." But if it is, in fact, unable to grasp the initiative and progressively unfold its battle operations, then, having won time for regrouping, accumulation and concentration of forces, it can nevertheless again become a system of the opposite type; but the enemy, having wasted this time, can lose all when there were conditions for a full victory.

Another example: "A strong, progressive movement springs up in a backward country, leading to the establishment and growth of democratic organizations. Subsequently, there arises a reaction against them— a series of constraints, repressions, blows, and external insults. How do these organizations react to the results? Let us assume they do this by broadening and intensifying their activity, deepening their slogans and passing to more radical forms of struggle. This characterizes the given organizations as systems of the second type; that is, points out that the possibility of their growth and victory is not excluded."

"But accumulated energies are being exhausted in the ongoing struggle. And now the time approaches when the practical character of these organizations appears to change. They begin to react to the growing pressure by limiting their operations, rejecting sharper forms of struggle and narrowing slogans. These processes are essentially internal changes which partially weaken the effect of external influences, i.e., correspond to the type of Le Chatelier, and express a tendency to equilibrium. Then the question is solved; a subsequent triumph of the forces hostile to them is assured: the very possibility of a successful struggle disappears until new structural changes in the entire social environment take place."[1]

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[1] Tektology, Vol. II, pp. 111-112. Most of the previous illustrations are also taken from there, but with new elaborations.

Assume that in this case some sensitive and experienced political figure has captured the essence of the situation by the analogies which he knows personally from life or history. But he is able to transmit to others neither his knowledge as a whole nor his practical sensitivity, and, therefore, his conclusions are not convincing to others. And, perhaps, the most vital elements would continue to expend their energies in the wrong direction, against the turning point of the wheel of history. Only a scientific organization of experience permits a real *proof* of such conclusions.

With all its breadth and importance, the principle of equilibrium is not a special, independent tektological law. It is a particular application, under definite conditions, of the principle which we have already explained— the principle of an "analytical sum."

In complexes of equilibrium there are always antagonistic activities which neutralize each other at a certain level, as, for example, in the system of "water-ice" molecular couplings and thermal motion of particles, in the physio-chemical processes of an organism, which create and absorb heat, and in common psychics opposite, mutually restraining groups of aspirations, etc. If such a complex is subjected to an influence, then new activities, which correspond to this or that antagonistic group, enter it from the external environment. Let these groups be A and B, and our external influence B_1, which is homogeneous with the second one. Can it amalgamate fully with B and without losses, without a partial disingression and, consequently, produce straight and direct changes in the system in its direction and up to its entire magnitude? As we know, this cannot happen; an ideally harmonic combination of a former and a new group of activities is not observed anywhere; a disingression is inescapable to this or that extent. Consequently, the operating sum of this group of activities will not be $B + B_1$, but lesser by a magnitude B_2, i.e., $B + B_1 - B_2$. To the original B_1 was in fact added $B_1 - B_2$, which also expresses the resultant change in the system. It is, as we see, less than the operating activity, i.e., the point is exactly as if processes arose in the system which were "so directed as to counteract" this disturbing influence; this is the law of Le Chatelier. The essence of this phenomenon lies simply in that the "analytical sum is always less than the arithmetic sum," as we already know.

This consideration does not apply to systems of disequilibrium, because a new influence changes the *ongoing* structural transformation there.

Thus, things which are most distant from each other in everyday experience can be united by tektological laws which embrace all *actual* and *possible* transformations of forms.

V

Divergence and Convergence of Forms

1. The Law of Divergence

Two complexes which are absolutely identical cannot be encountered in experience. The differences may be practically insignificant, but with an adequate investigation they can always be discovered. It is not possible to find two leaves among all the plants in the world which are completely alike; it is not even possible, as is clearly shown by the molecular-kinetic theory, to find two drops of water in all the oceans of the world which are exactly the same. This refers not only to "real" complexes, but also to "ideal," or mental ones. Geometricians can "think" of absolutely similar lines, i.e., denote them verbally as such, but these lines exist only in acts of thought; and the two sets of thought, even of the same person at different moments, cannot themselves be absolutely the same.

The most similar forms appear through the division or decomposition of homogeneous complexes; of course, this homogeneity is only relative. A crystal, a drop of distilled water, or a piece of a chemically pure metal can serve as examples of such complexes. Let us, as far as is possible, divide such a unity into two equal parts: no technology permits the achievement of a complete equality or a zero difference in magnitudes. Consequently, by reason of the original heterogeneity, no matter how insignificant, there will be some ***initial difference*** in the structure and dimensions between twin complexes.

This is not all. Their environment and external relations are inevitably also dissimilar. Let this environment be a "perfect void," i.e., the astronomic etheric environment; but even in this environment, pierced as it is by innumerable and infinitely varied waves of radiant energy, the electric and magnetic conditions at any two points cannot be identically equal. And if this environment is complex, or "material," i.e., molecular, then the differences are here incomparably more significant and varied. In one way or another, they always exist.

What is the subsequent fate of our twin forms? As with everything else in nature, they will evidently be changing. Can exactly the same, precisely parallel changes be expected? Clearly not. They must be different due to the original difference of complexes themselves, because unequal forms even under the same conditions change unequally due to the variety in the environment whose influences call forth changes.

Dissimilar changes attach to the initial differences. Differences grow. Therefore, subsequent changes must be even more dissimilar and the growth of new differences intensifies even more, etc. Consequently, the divergence of the initial forms is "avalanche-like," similar to the growth of magnitudes in geometric progressions; it is generally of the type of a progressively ascending series.

Let us consider a drop of water divided into two, almost equal parts. Then, in conformity with the laws of physics, the one which is larger will evaporate relatively faster in the same atmosphere. This simple quantitative distinction and the other more complex ones -- in the given case, concentrations of dissolved substances which are present even in the purest distilled water, and chemical interactions in these substances, etc. -- become departure points for the development of new, subsequent differences; and inasmuch as the separation puts the parts of the water drop under dissimilar conditions of the environment, it begets another factor of divergence. Two questions arise. The first is: was there a similar progress in differences going on prior to the division of the drop, and were not both of its parts, now mentally separated one from the other, different in the same respects? The second is: if distinctions grow as a function of the above two factors, would not both these factors develop them in opposite ways so as to avoid divergence or even produce something quite opposite?

The first question is solved in this way. The drop of water is a single complex just as long as all of its parts are in a continuous connection and interaction, in a constant *conjuction* and in an interchanging combination of activities. This, apparently, also determines the extent of the *equalization* of the emerging differences among the parts of the whole. For example, concentrations of dissolved substances change in various places of the water drop, but there also goes on an intermingling and diffusion which aim to destroy this heterogeneity. In separate drops such conjunction is absent, and differences can grow without hindrance; the divergence then becomes stronger.[1]

Since for tektology a full, absolute separateness does not exist, it can be stated that as far as separateness appears or develops, so far progresses the operation of the law of divergence.

The second question can be answered as follows: for individual complexes not only is divergence actually possible, but also ***convergence***. The influence of the environment on a given difference between complexes can turn out to be quite opposite and increase their similarity. Ancestors of the dolphin living on land differed more from the fish of those times in the form of their bodies than does the dolphin today. But each such case is determined by special circumstances which partly paralyze or camouflage the tendency to diverge, which, nevertheless, always continue to operate. Between the same dolphin and, say, the shark, divergence has not ceased to continue in this and other respects which are not related to the mechanical properties of the water environment. Consequently, the general law of divergence is not violated here, but rather its visible manifestations are counteracted by other tendencies. The law of gravity, for example, is not violated by the fact that an object thrown with force flies up, or that an air balloon rises and does not fall; any regular (lawful) tendency may be paralyzed by others which are equally regular (lawful) and which, in turn, are subjects of study. In the infinitely complex reality of living experience ***not even one*** tendency appears fully in isolation and in an absolutely pure form.

Further, customary methods of thinking still give rise to the following questions: is it possible to speak generally about the "divergence" of complexes, and, besides, complexes which are completely different? Can the differences which already exist, for example, between two chemical elements, grow still further? And if the atoms of hydrogen and oxygen in a drop of water are separated by the force of a galvanic current, will this lead to "divergence" in their properties and to an increase in the difference between them; that is, will the original difference be preserved?

But it is necessary to remember that any differences between complexes are relative and limited; therefore, a growth in differences is never excluded. This can be easily seen in the same example concerning atoms of hydrogen and oxygen, during the analysis of water when their correlations are studied more closely.

The chemical coupling of atoms is, of course, an ingression which presupposes the

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[1]Of course, the ease of conjuction plays an important role here i.e., the mobility of elements of the complex, its internal plasticity. For example, in a hard piece of iron, electrical and magnetic activities conjugate and equalize quite fast; thermal, however, much more slowly; and chemical, also comparatively very slowly, so that one of its parts may be completely rusted when the other parts remain untouched. The low mobility of elements is equivalent to their significant separateness.

presence of a linkage, i.e., some common elements between these atoms. Exactly what kind of elements are involved is not yet fully explained by the theory on structure of matter; it is assumed that the question concerns electrical activities which are expressed in the "lines of force" binding the opposite electrons. In any event, if the linkage breaks up, it should mean that its component activities are also paralyzed at some points by other activities which were supplied by the current decomposing the water.

Isolated atoms are then immediately grouped in pairs, but now hydrogen with hydrogen and oxygen with oxygen, composing particles of gases, bearing those names. However, the torn links close up so fast that it is not possible to observe the interval condition; it is revealed only indirectly in a raised "force of affinity," i.e., the chemical mobility of bodies *in statu noscendi* (at the moment of birth). And despite this elusive time, there occurs a significant process of divergence in properties.

The coupling of atoms of hydrogen and oxygen in a particle of water was conditioned, of course, by their definite *structural correspondence,* no matter what it consisted of. Once the coupling disappears, it follows that this correspondence disappears also. The change is similar to the disappearance of the coinciding threads or of their common elements in a nut and bolt this is a rough but a true comparison expressing the essence of the fact. The common electrical condition for the water molecule is now replaced by the two sharply different conditions for the new molecules of hydrogen and oxygen. There is also a change in the speed of "thermal" mobility: the water particles had a common speed for all atoms (the average under 0° is approximately 615 meters per second); after the separation, the speed is different for particles of water and oxygen (under the same temperature the first is approximately 1840 and the second 460 meters). The sum of differences has, evidently, grown, and it can be said with certainty that further development in knowledge will reveal other changes here in the separated atoms and, consequently, an even greater divergence. The same can be said about their subsequent fate in different environments of nature.

The law of divergence plays an important and guiding role in cognitive activity. It teaches us to search behind each diversity for that comparative unity from which diversity originated, i.e., to ascend from the complex to a more simple or more "primitive" – the word, expressing simultaneously both the primacy and simplicity.

But the practical meaning of the law is great and direct. With the dissolution of any material or non-material complex and with the breaking of any connections, the subsequent inevitable divergence of isolated parts must also be considered beforehand. For example, splits in organizations which occur in the political and cultural life of our epoch, which is full of contradictions, would probably be less frequent, if the leaders always clearly understood that in a partial and temporary separation is inevitably concealed a tendency toward a deeper and irreversible one.

2. Complementary Correlations

A full break-up of connections and absolute separateness of complexes does not and cannot exist in our experience, which is united by universal ingression. But degrees of separateness are quite varied. In order to solve a problem, it may be sufficient to take into account separateness in some cases, in others it is also necessary to consider connections.

Thus, if the concern is with the propagation of an amoeba or bacteria, then daughter-cells, which diverge in various ways, may be considered in the closest investigation as fully separate organisms. However, if the question concerns the fate of not only this or that cell, but of the entire species, then it is necessary to take into consideration the linkage of species, which clearly manifests itself after a series of generations in a peculiar union between cells -- in copulations or conjunctions. And the propagation of the embryonic cell of a complex, such as, for example, the human organism, should from the very beginning be studied from both points of view. Here daughter-cells do not separate from each other, but remain in a direct communication and intercourse, although they are not merged into one. A continual chemical conjunction is maintained between them, at first directly and later, when they multiply, indirectly through the lymph and blood, which constitute the common internal environment of the organism. Naturally, the law of divergence is also limited in its operation in relation to the chemical content of cells and the tissues which are formed from them. With all the variety of this content, a considerable community of chemical structure remains; it is this community that serves as a carrier of individuality and heredity.

When in the process of solving a tektological problem the givens simultaneously include separateness and couplings of complexes, i.e., when it is necessary to study changes in a *system consisting of separate parts,* then we have a problem of *systematic divergence* ("systemic differentiation"). We have already considered one side of this problem: the principle of relative resistances; the law of the minimum gave an answer to the question concerning the conditions of preservation or destruction for such systems. Now we will go further and, assuming that the system is not being destroyed, shall investigate how and in what direction it ought to change and develop under different influences of the environment.[1]

We already know two important things about the preservation of complexes: first, their preservation is never absolute and is always approximate only; second, it is the result of a dynamic

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[1] Cases of destruction will have to be studied separately, with the theory of systemic crises.

equilibrium of the system with its environment, i.e., it is created by the two flows of activities-assimilations: the absorption and assimilation of activities from outside, and the disassimilation of activities, their loss or transfer to the external environment. And this means two uninterrupted and parallel series of processes of progressive selection, both positive and negative. They can equalize quantitatively, with fluctuations in this or that direction, but each, as we have already seen, performs by its very nature a special tektological role and has a special influence on the structure of a system. Together they both regulate its development.

In what direction do they regulate this development? Obviously, in the direction of the most stable correlations, since the less stable correlations must be gradually eliminated, and the more stable are strengthened by positive selection.

At the same time, this development, it should be remembered, is achieved through divergence, inasmuch as parts of the whole possess separateness. In this way *differences grow,* leading to *increasingly more stable structural correlations.* We shall present this concretely.

Here is an embryo of a plant. With propagation, cells find themselves in an increasingly dissimilar environment: some go deeply into the ground, others rise into the atmosphere; being originally the same, they inevitably change in the sense of a growing divergence. Its basic line is determined by the fact that there are dissimilar prevailing materials for assimilation: in the soil, mainly water and salts, in the atmosphere, carbon dioxide, oxygen and the energy of the sun rays. Both types of materials, however, enter into the structure of all cells, i.e., they are assimilated and disassimilated by all the parts of the body. In what direction should selection direct the development? Which correlations of the diverging parts will be most stable? The correlations which enable these parts to *complement* each other; and this is quite possible exactly thanks to the preservation of their linkage, which maintains the common internal environment through the movement and exchange of sap in the plant. The cells of the root assimilate in plenty certain elements from their closest environment; the cells of the leafage and the trunk, other elements; they pass to each other any surplus by conjunctive means, mutually sustaining their structural stability. These are *complementary correlations.* Those differences develop which raise the connectedness, stability and durability of the system under external influences, or, in a word, its organization.

The above example refers to the most typical group, to cases of the "division of functions" or specialization. These cases are innumerable and infinitely varied in the realm of life. Here is another illustration: the primary, so-called "physiological" division of labor between men and women in the patrimonial group at the dawn of the evolution of mankind. The female organism is of necessity less mobile than male from the very beginning: pregnancy, nursing and care of children significantly bind the woman to one spot and create for her a more constraining environment than that in which the man operates. Thanks to this, in the procurement of the means of livelihood — and it is a social form of assimilation — plant-objects, such as roots, fruit and seeds, are more accessible to women; men, however, can hunt animals incomparably more freely. At the same time, being longer on one spot, women are able to subject the acquired materials to a full processing, thus facilitating assimilation in individual consumption. The systemic divergence, therefore, proceeded so that the male and female parts of the commune increasingly complemented each other in production: men, as hunters, procured animal food, skins and wool, and later established cattle-breeding; women supplied the major part of plant material for food and with the passage of time laid the foundation of agriculture: moreover, women predominantly prepared this or that food for consumption and made clothing from skins and wool, etc.

The complementary correlations unfold even further and deeper in the most recent division of labour. The system of production is organized here so that each member of society performs but an immeasurably small part of those transformations in the environment which are directly indispensable for the preservation of his personal life; the rest is conjunctively given to him by his social environment; but this environment assimilates, as if spreading and distributing in it, almost the entire sum of the results of his individual labour: what share, for example, does this or that worker consume of what he has produced himself?

In the human organism, representing a colony of 50 - 100 billions cells, it is almost impossible to isolate, even mentally, the share of participation of each cell in the common struggle for survival with external nature; assimilation occurs for each separate cell at the expense of the internal conjunctive environment of the organism (blood and lymph), with the exception of a part which should be practically considered as infinitely small. This is the result of the systemic divergence which begins with a uniform division of one cell.

A similar line appears just as clearly in the development of the psychics. The chain of images, feelings and volitional impulses, relating to hostile forces in the environment, and the chain relating to its friendly forces "divide" the regulation of motions of the organism between them: one of them "assimilates" from psychic reactions what is not suitable for the other, and vice versa; each chain actively appears so as to complement the other in order to maintain the whole as its special organ. Each of them, in turn, is composed of smaller, specialized psychic organs — "associations," and these form even smaller separate psychic reactions; everywhere there is a division of functions.

The complementary correlations appear even more distinctly in such systems as contemporary languages, science, law, ethics and, generally, any complex cultural form. "Parts of speech" functionally complement each other; so do different fields of science and law, etc.

The entire realm of life on earth can be considered as a single system of divergence. It branches out into two "kingdoms" — plant and animal; complementary correlations in many respects exist between them. One of the most important and remarkable among them is the rotation of carbon dioxide. In the organisms of animals it is a waste matter, but for plants carbon dioxide is one of the main means of nourishment; and oxygen, which is discharged by the green, chlorophyll parts of plants, serves for animals as the material for breathing, as, among other things, it does also for the plants themselves; generally, the complementary character of couplings is not perfect here. But as far as it exists, so far are the processes of assimilation-disassimilation in both kingdoms mutually opposite; this enables the stability of both parts of the system to grow to an enormous extent.[1]

But the same rotation of carbon dioxide forms a basis for complementary correlations between life as a whole — the "biosphere" — and the gaseous cover of the Earth — the "atmosphere." The quantity of carbon dioxide is maintained at a definite, stable level. If, due to the development of animal life, forest fires and also a discharge of carbon dioxide in volcanic processes or from other sources, there is an overproduction of carbon dioxide, then the growth of plants immediately intensifies at its expense, and the surplus is absorbed; if, on the other hand, the plants significantly decrease the content of carbon dioxide in the air by excessive multiplication, then animals in turn, utilizing the surplus of their basic food, the plants, multiply intensively and thus increase the mass of the discharged carbon dioxide. Thus the stability of atmospheric content is sustained by the biosphere, which draws from the atmosphere the material for assimilation.

This illustration is interesting because it reveals a possibility of complementary correlations not only among forms of life in which we are accustomed to find and observe them. The "division of functions," "division of labour" and "specialization" are all biological and social notions; they easily suggest the thought that the principle of complementary correlations is applicable only to "living" nature, but not to "dead," inorganic nature. But such a thought is quite erroneous. Tektological bases of complementary correlations— assimilation and disassimination and processes of selection— are peculiar to the entire "living" and "non-living" world, so that this organizational tendency must also be equally manifested both here and there under systemic divergence. Careful investigation supports this conclusion.

Such is, for example, the connection of the same atmosphere with the "hydrosphere" — the water part of the Earth's cover. A whole series of conjunctive couplings exists between

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[1] Some unicellular water plants live in a "symbiosis" with unicellular animals; so does the green zoochrella in the body of the vorticella; chlorophyll elements of zoochrella decompose carbon dioxide of the vorticella's bre. and discharge from it carbon for the production of carbon hydrates, which are necessary for zoochrella, where the released oxygen serves again for breathing of vorticella. The same form of complementary couplings, but what a difference in scale.

them: rotation of water-steam, dissolution of air gases in water; thermal and electrical exchange, etc. Here too, both sides regulate each other, mutually supporting their stability. So the atmosphere loses its gas-like water through rains, snow and hoar-frost, etc.; the hydrosphere receives it in the form of streams and rivers, directing them into the seas and oceans; but, in its turn, it returns to the atmosphere approximately the same quantity of water through evaporation. The stability of systemic temperature is supported by an unbroken air cover which arrests the heat of the hydrosphere and also that of the "lithosphere," the hard part of the Earth's crust which is supplied almost entirely by the rays of the sun; and the hydrosphere, having an enormous thermal heat capacity, forms, as it were, a reservoir, which now absorbs the surplus of thermal energy which the heating intensifies, now releases this surplus to the air and, through it, to the lithosphere when the heating decreases; in this way the fluctuations in temperature are maintained within limits around one basic level.

It is necessary to note that the heat arresting function of the atmosphere, in its turn, is regulated by an exchange of water with the oceans and seas, and partly also by an exchange of carbon dioxide with the biosphere. The point is that the main constituent parts of the air -- oxygen and nitrogen— possess a very small arresting ability, and the watersteam, of which comparatively little exists in the air, a tenth of one percent, and carbon dioxide, of which there is even less, exceed them in this respect 16,000 times. Thus, the regulation of their quantity by conjunctive couplings between the three spheres is a basic condition for the maintenance of a stable, on average, level of their temperature: this is a typical complementary correlation.

Here, in this way, this correlation clearly appears between organic and inorganic complexes, and equally also between inorganic complexes only. And this arose as a result of evolution within the system of divergence. There was a time when the atmosphere also contained the entire present hydrosphere in the form of water-steam: the temperature of the Earth's crust was measured in hundreds of degrees and the water could not be a liquid. With a lowering of the temperature, the "water" and the "air" separated; and then "life" also sprang up from them; life in its basic content is a combination of the same chemical elements which form the atmosphere and oceans: oxygen, hydrogen, nitrogen, and carbon with an addition of still other elements, which, in the form of soluble combinations, are also present in sea water. Complementary correlations between the partly separated gigantic groupings of elements of the Earth's cover have evolved over hundreds of millions of years by a series of innumerable processes of selection.

Inorganic nature, which is generally characterized in comparison to the organic world by a greater simplicity of organizational forms, naturally provides also the most simple models of complementary correlations. Here is one of them.

Let there be a saturated solution of some salt; crystallization goes on in it. This is a process of breaking former connections, the process of separation of the two parts of a given system and at the same time their divergence. It leads to a new coupling of the two parts: the solution is not oversaturated but only saturated; and on contact with the solution, the least surface is formed. When this condition is reached, then there appears, between the liquid and the solid "phases" of the system, a stable interchanging correlation, a rotation of the dissolved substance. Crystals continuously lose or "disassimilate" particles which are dissolved, and are in this way "assimilated" by the liquid; and conversely, the liquid loses particles which by settling down on crystals are assimilated by them; the two flows of exchanges equalize and the form of the entire system is preserved. This is not all: under definite conditions this form is restored after a disturbance by external influences. For example, assume that a small piece is broken off from a crystal. Then the surface of the interchanging interaction of both phases grows and the interaction intensifies. The solution gradually eats away the broken-off piece and in exchange deposits particles on the crystal, so that the "wound" heals up. Both sides, as if in common, regulate the form of their contacting surface.

This example, in its simplicity, conveniently formulates the very essence of complementary correlations. It reduces to the *interchanging linkage:* in it the stability of the whole, the system, is raised by one part assimilating what is disassimilated by the other, and conversely. This formulation can be generalized to all complementary correlations; in some cases its applicability is evident, but in other more complex cases, it is discovered only by scientific analysis. Thus, in the life of society with its division of labour, the exchange of products is an expression of an exchange of labour activities. A farmer spends, i.e., disassimilates his labour energy on the production of bread; society "assimilates" this energy through the consumption of bread; at the same time other labour elements of society "disassimilate" other forms of labour energy, creating other products; and the farmer assimilates those forms of energy, consuming the products which are received in exchange for his bread. In the organism, the picture is even more complex, and it is even more difficult to isolate concretely what this or that cell "assimilates" from the whole through the mechanism of its decomposition (circulation of blood and lymph, nerve impulses, etc.), and what the cell "disassimilates" to its advantage, along with those of its elements which it dischages as already unnecessary to the organism. But the meaning of the correlation is the same. Inorganic nature presents a great number of cases of incomparably simpler interchanging linkages. In part, they apparently slip away from our attention exactly because they are too simple and ordinary and do not arouse an interest to investigate them; partly, however, because they were not studied from our point of view.

Complementary correlations, as all organizational correlations in general, are sometimes imperfect; the interchange of activities is not being carried out to the very end. So, for example, in the division of labour the farmer partly consumes his own products himself, and does not give them to society; equally, most other producers also do this to various degrees; besides, along with the interchanging couplings there is also often discovered a struggle, a mutual contradiction of parts -- among the same members of society, or among the individual cells of the organism; also, a part of the activities given by some of them to others often does not serve the purpose of assimilation, but on the contrary, the purpose of the weakening and destruction of the latter, i.e., produces in them a loss, or disassimilation of activities. But it is precisely in the inorganic world that it is possible to encounter, apparently, the extreme development of interchanging connections. There are cases of so-called electrical and magnetic "polarity," where the opposite currents of activities especially support each other in definite equilibria.

Usually, such cases are not at all considered from our point of view. For example, the connection of magnetic poles, the "north" and the "south," are not understood in the sense that one of them "assimilates" activities which are "disassimilated" by the other, and conversely. However, the same idea is expressed, but only latently, in the usual formulas according to which one pole "absorbs" the force lines which "emanate" from the other pole. The "force lines" forming "force currents" are, of course, a denotation of some activities, which are not determined more precisely, but are discovered in completely clear actions; and, consequently, the "emanation" is in its essence a kind of disassimilation. This is quite evident in the galvanic current: the positive pole assimilates the energy originating from the negative pole, and conversely; they only exist so long as this circulation continues. The atom is also now being understood as a system consisting of an electrical "positive nucleus" and negative "electrons" or "corpuscles"; moreover, both sides are in a continuous interaction; it is also almost perfectly balanced in most of the elements whose atoms are "firm," and noticeably unbalanced in radioactive substances. And "interaction," in general, cannot be conceived in any other way than in the form of the mutual transfer of activities: loss on the one side, passing to assimilation on the other, and conversely. When, however, the *stability* of a system is achieved in this way, i.e., its *preservation* in the midst of destructively directed influences of the environment, then it is clear that this is a complementary correlation, similar to an interchange of labour energy or a chemical interchange of vorticella and zoochrella, etc. And if this stability approaches as high a degree as that existing in the case of most atoms, with the period of life supposedly not less than millions of billions of years, then we are forced to think that these complementary relations are most highly developed and are the result of an extraordinarily long systemic divergence under the conditions of extraordinarily intensive selection.

So, in all the realms of experience and at all the stages of organization one and the same general regularity is confirmed:

Systemic divergence contains in itself a tendency of evolution, directed towards complementary connections.

It is natural and clear that man in his practice follows this regularity, in the sense that he submits to it independently of his will, and uses it insofar as he assimilates and consciously masters it. This, first of all, is ***the principle of the entire social technology.***

The entire system of production, taken as a whole, is composed of ***people and things:*** workers and means of production, socio-labouring activities on the one hand, and the energy of nature acquired by society in the form of instruments, materials and products, on the other. The correlation is obviously the same: the aggregate of things in production complements the cooperation of people; the work-energy of people is maintained and reproduced at the expense of things by assimilation of their energy through the consumption of products; on the other hand, the expenditure of labour energy by people serves as a means for maintaining and reproducing the complex of technical things; the stability is thus mutually conditioned, and on its basis also rests the development of both parts of the system.

The same principle also rules over each of the parts of this system. The axe and the saw functionally complement by their activities, which are hidden in the material form, a human organ, the hand; and they receive from it, or "assimilate" activities of their own operation and application. In the axe itself or in the saw each part adapts to others so as to have them all functionally complement each other by means of a mutual transfer, i.e., the chain of assimilation-disassimilation of activities.[1] The more perfect each instrument becomes, the more strictly and precisely this correlation is realized. Machines, however, are a higher type of instrument; in the division of the functions of their parts they often resemble the living organism to an extreme, especially those rare mechanisms which are automatically regulated; such, for example, is a self-propelled submarine torpedo, with its complex motor, its depth and direction rudders, etc. It can be said that the machine, a product of the most conscious forms of creativity, is constructed by man more and more in his own image and likeness: no wonder that it replaces his labour force in an increasingly greater number of cases.

Systemic divergence is directed on lines of complementary relations by the force of selection; and "consciousness" represents an apparatus of the most intensive selection of the most complex and varied combinations; therefore, it is understandable that this direction appears especially clearly in its work. And not only technology, the field where man with the aid of consciousness organizes things, but also other spheres of his activity, where people themselves are organized in a collaborative whole as well as experience and ideas, are permeated by the same tendency.

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[1] So the axe-handle "assimilates" the energy of motion which is "expended" by the hand. The moving jolt is given at one of its ends and passes to the other in the form of a wave of compression, so that each subsequent part begins to move to the extent of the assimilated energy, following the preceding one after some period of time, which may be very short, but theoretically quite measurable. In this way a part of this energy is "disassimilated" by the axe-handle and "assimilated" by the blade.

An experienced organizer in any field, whether he organizes an economic enterprise, a government department, a professional or a political group, always endeavours to combine people so that they complement each other in the interest of the matter on hand; if necessary, he directs the very preparation and training of each of them in a corresponding way, i.e., directly calls forth their desired divergence in the direction of complementary relations; and he aims to utilize even the narrowness of separate individuals so as to facilitate the performance of their special roles, which must be chosen in full correlation with the task.

The organizer of experience – a scientist, philosopher, artist -- also aims to work out the same correlations in his concepts, schemes and images. Let there be a classification of living organisms, in the first place, into "animal" and "vegetable." It is stable, i.e., satisfactory only as long as any living body which does not fall within the limits of the concept "animal" finds a place for itself within the limits of the concept "vegetable," and conversely. When it turned out that some organisms, combining elements of both types, did not fall precisely into either of them, i.e., that the complementary correlation of the two concepts was partial and imprecise, then the system had to change. Haeckle attempted to single out the third kingdom - "protists," where forms would enter which have not been adequately defined one way or another; other biologists preferred to use a complementary concept of interval types; still others, instead of juxtaposing vegetable and animal life, took the vital functions as the basis for vegetable and animal type, etc. And exactly in the same way the content of each of these basic concepts must be distributed between more particular concepts so that they would fully complement, and only complement each other; only under this condition is a classification recognized to be quite strict and logical. And departure from complementary relations and any incompleteness in them is considered to be an imperfection, a defect of the system, which pulls the changing work and active selection away from scientific thought. [1] The problem is, therefore, posited in this way: a given system of concepts must embrace ***all*** the richness of living forms, and each from the cycle of its concepts must be ***fully*** complemented by the totality of the rest, and itself complement them in the same measure.

The problem for any scientific theory, philosophic doctrine, legal or ethical system is posited in a similar way. And the same tendency lies at the base of art: the work of art requires that the complementary correlations be strictly adhered to among the component complexes -- images and their combinations.

Where the principle of complementary correlations is not adhered to in a given system lie the points of lowered resistance. In particular, the realm of "spiritual culture," ideology

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[1] It differs from "everyday" thought by its higher rigour, i.e., intensiveness of this selection.

is distinguished by a special intensity of negative selection, because this is the highest organizational realm of social life; here such areas of unevenness become points of application for the disorganizing work of criticism; as a result, there is either a general downfall of the system or its partial destruction followed by a reconstruction.

As we can see, the regularity of systemic divergence -- "differentiation" – is the same in all fields and at all stages of existence. The higher is the level of organizational forms, the greater the distinctness and strictness with which this regularity is revealed.

3. Contradictions of Systemic Divergence

Systemic divergence also contains in itself another tendency. Together with the condition of stability and complementary relationships, it also develops definite *conditions of instability:* gives rise to "systemic contradictions." These contradictions, at a certain level of their development, are even able to surpass the role of complementary relationships. Cases of this kind are innumerable in experience; they are the basic material for the poetic formula of Goethe: "The absurd became wise, and the good was converted into evil."

Any complex organism, such as a human organism, progressively develops up to a certain limit through differentiation of elements, beyond which begins its decline, old age. This decline, in turn, progresses right up to its natural end, death. What is the problem here?

Systemic divergence means an increase in organizational distinctions among parts of the whole, an *increase in tektological variety.* And this forms the basis of contradiction.

The strength of the organism lies in the precise coordination of its parts and in the strict correspondence of separated and mutually connected functions. This correspondence is maintained through a constant growth in tektological variety, but not without bounds: there comes a moment when it cannot be fully retained and begins to diminish. Parts of the whole become "too different" in their organization; so different that they drift apart both in terms of the *tempo of life* itself and in terms of *the strength of their relative resistance to the environment.* But this inevitably leads to disorganization, slower or faster, depending on the totality of conditions.

The influence of divergence on the tempo of life can be easily and clearly explained by the following analogy. Let us assume that a watchmaker has made several quite precise clocks and put them into motion at the same time; their winding, however, operates over an indefinitely long time, or the clocks are wound up as needed, but are not checked. According to the law of divergence, the clocks will deviate unequally from the true time: some will be fast, others slow, and to different degrees. In order to compose one whole, as an organism, their hands, let us assume, are tied with threads. It is clear that under these conditions they will inevitably stop each other sooner or later.[1]

It is not difficult to imagine in what way the lack of correspondence in the tempo of mutually indispensable vital functions can and must step by step disorganize the entire system. For example, kidneys serve for the discharge of definite poisons, which are formed from the vital activity of the body tissues as products of their continuous partial disintegration -- disassimilation. It is sufficient for the activity of kidneys to fall behind this process, and the organism will be chronically poisoned.

The lack of correspondence among the relative resistances of the various elements of the body disorganizes it even more directly. The less stable elements are simply forced out by the more stable ones: the first die off comparatively faster, and if they propagate, they do so comparatively more slowly than the second. So, in old age, the most specialized cells are nervous and gladular, etc.; they are forced out by the cells of conjunctive tissue, the least specialized and the most stable cells under harmful influences.

Apparently, there is even a progressive extermination of cells of the higher type by so-called "phagocytes," i.e., the "eating cells"—white blood corpuscles and some other elements having the same capability. The process of selection perfects all cells in their specialized function. In a series of generations of phagocytes, those of them which are most adapted to their role also survive and propagate, i.e., those which in their everyday struggle more easily conquer bacteria and all other living cells. In the same way, cells of the liver and kidneys adapt better to the conditions of their activity: they endure a great quantity of poisons which they discharge from blood, etc. But this does not mean that their resistance to an increased fighting force of phagocytes also grows. Besides, phagocytes are not at all concerned what they attack, whether alien or their own cells, and they devour without distinction those elements which are unable to offer sufficient resistance.[2] This alone ought to, in the final analysis, inevitably lead to a decline of the organism.

Contradictory tendencies in social life appear even more graphically with the development

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[1]This analogy with simultaneously wound up parts served the old philosophers for explaining the pre-established harmony among the elements of the universe -monads, or between the body and soul. Since such a harmony does not exist, the comparison is especially suitable in explaining the development of disharmonies.

[2]They strictly "select" their objects, i.e., attack some, do not attack others on the basis of so-called "chemotropism": a chemical attraction and repulsion; for example, some of the bacteria attract them chemically, others, on the other hand, provoke repulsive reactions. But because phagocytes must normally eliminate the damaged, destroyed or even simply unnecessary cells of the organism itself, their chemotropism cannot generally save its tissues from them.

of the social division of labour. It has enormously raised the productivity of the efforts of mankind; but it has also led to disintegration of the originally holistic communes into separate households which became related only by market exchange. And in market exchange, the collaboration of separate households has the form of a *struggle* over price between buyers and sellers, over markets among sellers, and over the possibility of buying goods among buyers. Struggle, however, means that activities are directed in opposite directions and that they destroy each other to this or that degree, i.e., that there is a presence of disingressions; although it can produce progress in the *results*, the struggle by *itself* is a disorganizing phenomenon. This also concerns struggle in the market place. By observing the process of trade, especially in its primitive, asiatic forms, it is impossible not to see that it reduces to a series of mutually destructive efforts, which in the aggregate sometimes amount to a significant expenditure of energy, especially when they end with a break-up of negotiations; consequently, a complete disingression of the expended activities occurs. Even more significant are those disingressions which are contained in the efforts of competitors to undermine each other, and those which subsequently arise from a general disparity between demand and supply on the part of various industries, etc.

On the basis of market struggle and from the very same division of functions there also arises the struggle among classes, with its enormous growing disingressions, and the struggle among social groups, the individual groups which are organized according to specialization within classes ... Thus disingressions grow and accumulate, diminishing the living force of development. But until recently this force, nevertheless, far outweighed them. In this growth of contradictions it is easy to catch the same two basic moments. The divergence of pace in separated functions is revealed because separate branches of industry, supplying each other with instrumen and materials, grow disproportionately: some of them lag behind, others press forward, so that for a great number of them there is insufficiency of either sales or the necessary means for their work. Also, production as a whole subsequently outdistances the growth of consumption, and as a result there arise general crises of "overproduction," with the enormous destruction of productive forces and widely unfolding processes of disorganization.

The divergence in the magnitude of relative resistances leads to disingressions: from a number of parts of the whole – businesses and enterprises – the weaker fall to the ground in the struggle and competition with the stronger; with this, a part of the disorganized economic activities, i.e., the labour force and means of production, are absorbed or assimilated by the conquerors; this is called the "concentration" of businesses or enterprises; and the remainder perishes fruitlessly, dying off, decomposing and dispersing in nature.

The development of both moments of divergence increasingly deepened both the mutual isolation of extensive parts of the system and their practical disingressions. At a definite level they inevitably had to surpass the force of complementary relationships among parts and led to a break-up of those relationships, to a general crush of the organizational form of the whole. The result had to be either a transformation of the structure or a simple collapse. Exactly such a situation had occurred in the latest financial capitalism; in the gigantic crisis of the World War and revolutions that emerged from it.

It is easiest to trace contradictions of systemic divergence in society, since it is a field of experience which is closest to the observer and most accessible to him. Here it is possible to note a disorganizational side of the process even when it is still negligible in comparison with the positively-organizational side; for example, from the very beginning, the division of labour could not but lessen, though to a small extent, the mutual understanding among people, on which is based the attainment of precision in coordinating operations. It is much more difficult to ascertain the same duality of correlations, for example, in a separate organism. However, the seeds of struggle and competition along with an interchange of activities, undoubtedly appear at the very first stages of the division of functions and long before the beginning of decay. They emerge quite clearly in various disturbances and diseases connected with the growth of the organism itself. Thus, the competition of tissues for nourishment is revealed in the emaciation of the body during periods of rapid development of the skeleton or nervous system, and also often during pubescence. The above mentioned facts concerning "phagocytes" also indicate a direct struggle, etc. In pathology, the science of diseases, pictures of similar contradictions are much more vivid and are encountered at each step. But contemporary science accepts that pathology differs from physiology and abnormal processes of life from normal in essence, but only relatively: proportions of various elements and functions are disturbed, but essentially nothing new is created; some of the regular tendencies are exaggerated, others are weakened and their equilibrium is upset, but nothing more. Consequently, in the struggle among cells or tissues of the organism, which is observed during illnesses, the abnormal intensification of some moments or features of their ordinary, physiological struggle can be seen with full justification.

Intricate technical complexes, such as machines and scientific instruments, present a convenient illustration of the development of systemic contradictions. Their perfection chiefly takes the form of a progressive differentiation of parts, a sort of development of organisms. An instrument is made more complex so that it can perform its assignment with greater intensity and precision, but it becomes, at the same time, more "tender," i.e., more accessible to disorganizing influences. A grain of sand or even dust, a sharp fluctuation in temperature, humidity or electrical tension are often able to lead to the damage and unfitness of such an instrument: with an enormous number of complementing parts their relative resistances to such accidental, even at times not considered influences, must be quite different; and the fate of the whole is determined, of course, by the least of them; besides, such influences are not at all simply "accidental"; they are, in general, a necessary moment of the environment, and only the appearance of this or that of them is accidental at this or that time. Subsequently, of course, the sum of their "frictions" grows with an increase in the number of parts, i.e., internal disingressions in their movements. Consequently, here too differentiation can be organizationally convenient only to a certain limit, beyond which its contradictions become preponderant. Then the machine is rejected because of excessive fineness and complexity, as was the case with many mechanisms invented for industry and the military, and many scientific measuring, self-writing and self-regulating instruments.

The previously mentioned group can serve as an example of contradictions which arise from systemic divergence in organic nature: "the atmosphere, hydrosphere and lithosphere." The hydrosphere "eats away" the lithosphere, drawing dissolved substances from it and destroying its crystalline rocks. The hydrosphere gradually takes oxygen away from the atmosphere througn dissolution, passing it subsequently to oxidizing substances of the hard crust where it remains. The hard crust, in its turn, takes water away from the hydrosphere for the crystallization of some of its rocks, oxygen from the air for the oxidation of others, and even a quantity of nitrogen in the form of ammoniac and saltpetrious salts which are formed with the aid of certain microbes in the biosphere. The carbon dioxide in limestones, chalk rocks and dolomite was also extracted from the atmosphere in former times. But the air together with water also constantly affects the lithosphere in a destructive way through "weathering," which pulverises the hard rocks. Thus, along the complementary relationships among the parts of the Earth's crust, there appear, although quite weak during our geological epoch, mutually disorganizing correlations which depend on the difference in the content and condition of those parts.

Contemporary theories on the structure of matter, as we have seen, make it reasonable to believe that atoms are highly differentiated systems of "polar" structure, with a positive electrical nucleus and negative electrons whose movements are dependent on the nucleus. But at the same time, these theories present atoms in the process of decay, which occurs only at different rates, from immeasurably slow to immeasurably fast rates; this destruction assumes, of course, systemic contradictions as the cause. If matter decomposes now, then sometime in the past it must have been put together, organized and progressively developed. The development in this case must have occurred through the systemic divergence of elements forming atoms, which has led to a complete polarity. If so, then it is quite natural to think that the ongoing decomposition of atoms is the result of contradictions and their extreme systemic differentiation developed over billions of ages.

Thus there is a duality of systemic divergence at all levels of organized existence: the development of forms of greater and greater stability through complementary relationships and their eventual disintegration through accumulated contradictions.

4. The Solution to Systemic Contradictions *(contra-differentiation or integration)*

Systemic contradictions give rise to an organizational problem, the problem of their solution or removal, which becomes more urgent, the stronger is their development. Life solves this problem either in a negative way – the system is destroyed; for example, the organism dies; or in a positive way – by a transformation of the system, freeing it from contradictions. The first case will be considered in the study of systemic crises; the second will be taken up now.

This solution is in essence very simple. If disorganizing contradictions arise from the *divergence* of parts of the system, then only what lessens or eliminates this divergence can weaken or remove them, i.e., obviously, *conjunctive* processes among the parts in question. This is exactly what happens in reality.

Here is an illustration from the realm of complex, but familiar social phenomena, the problem whose solution was frequently advanced by novelists. A husband and wife are engaged in conformity with the principle of complementary relationships; he in so-called "affairs," she in domestic work. They differentiate their activities on this basis to the extent that in many things they begin to have difficulties in communicating with each other. There appear misunderstandings, conflicts in petty things, arguments and quarrels; the family step by step begins to disorganize. The outcome may be either its destruction – a severence of the complementary relationship itself, or a revolution in the relations between the spouses. If they understand the real reason of the discord and, aiming to come to an agreement, intensify their interaction and begin to acquaint themselves closer with the affairs and interests of each other, in short, develop a mutual *conjunction* of their experience, then the harmony of the family may be re-established on new bases, broader and deeper then before.

The solution is simple, but it contains a definite tektological difficulty. In essence, it represents contra-differentiation, i.e., it is opposite to that of divergence which gave rise to complementary relationships. Are these relationships adequately maintained under such conditions? If not, since the stability of the system depends upon them, the result then must turn out to be negative.

In our example it is possible to have the following course of events. The husband is so occupied with social and party affairs, that he can devote neither time nor energy to an exchange of experiences with his wife without detriment to these affairs; and the wife, in turn, is so enslaved by her children, the kitchen and cleaning duties, that she also has not any free energy left and can be distracted from all this only at the price of overstraining herself, accumulation of petty failures and shortages in her household and its gradual disorganization. The attempts to resolve the problem bring both parties to discontent with themselves and each other, to the development of new disingressions in place of the old ones which are being surmounted and, if the minus is not covered by the plus, to a final downfall. Such an outcome is the more probable, the further the differentiation has succeeded to advance, and the more difficult it is to achieve mutual understanding, i.e., the actual intercourse of both parts of the system.

Meanwhile in other cases, contra-differentiation leads not to weakening, but to broadening and perfection of those very same special functions. And not only because it increases the practical sum of activities of the system by lessening disingressions, but still in another way.

Let us assume that the husband, living a socio -political life, has to deal with broad masses, indefinitely unfold for his consciousness and find themselves in a vague ferment, whose regularity is far from being formed in his mind; their strength now crystallizes into an unexpectedly mighty, triumphant transport, now spreads and dissipates into an elemental apathy; at times the success of the boldest plans is achieved with astounding ease, at others it is gained only through the most intense and stubborn efforts. Because of the changeability and instability of the environment, our politician develops a point of view and methods which include shades of utopianism and adventurism: he makes statements of broad and deep problems, but quite frequently without sufficient consideration of their feasibility; has bravery and decisiveness of implementation, but also a kind of play with uncertain risk. Hence, failures inevitably arise, at times quite severe, which could have been avoided with a different attitude to the matter in question. On the other hand, the wife is forced to develop a maximal organizational regularity and practicality in her narrow sphere: she is forced to calculate everything precisely, to anticipate and to coordinate all the small things of her household without the opportunity of consulting anyone else. This leads to the formation of a point of view and methods of limited practicalness.

What happens under a successful contra-differentiation? The result is the mutual assimilation of methods which developed in different situations and with different functions. The husband acquires a share of the practical soberness and organizational economy which is missing from him; the wife acquires more practical breadth and organizational boldness. That the first is necessary and useful under any conditions, does not have to be proved; that the second is important even in the narrow limits of the family household, is easily illustrated by such problems as guidance in the upbringing of children and subsequent assistance to them on questions of marriage, etc. Both special functions gain then as such; their "coefficient of useful action" is raised.

The development of mankind was accompanied by a resettlement of people in various territories and an adaptation to their special environment. Thus communes of the same tribe, tribes of the same nation, nations of the same race and, finally, with accumulating differences, special races were isolated. The divergence had a systemic character: the gravitation to complementary relationships was clearly manifested in that the separated groups and collectives had developed with the passage of time an exchange of their special products and dissimilar experience. Systemic contradictions were displayed in a growing cultural alienation, lack of mutual understanding – here a divergence in the field of language is most prominent – a collision of interests, hostility, wars among tribes and nations and a colossal expenditure of energy, which arose out of all this. These contradictions were also weakened and surmounted by contra-differentiation, in the form of all sorts of conjunctive processes: marriage mixtures, mutual influence of dialects and languages, borrowing of technical methods, knowledge and customs, interaction of literatures and,generally,in the form of all kinds of mutual cultural assimilations. The stronger is the assimilation, the more organized, the more stable becomes the cohabitation of tribes, nations and races on the Earth's surface.

The usual process is as follows: the deepening of differentiation leads to the accumulation of contradictions; sooner or later this is settled by a crisis. The forms of crises were different: most often, a war ending in a peace agreement or a conquest; sometimes, even in the absence of war, an allied agreement or formation of common organs of authority regulating the relationships between the parties. The solution to the problem was sometimes positive, successful, and sometimes negative – ending in a collapse and decomposition of connections; both are possible with any form of crisis. War, for example, has frequently brought the fighting parties to the closest conjunction, a merger with equal rights or the absorption of one party by the other; but it has also happened that a peaceful state or an allied union has subsequently led to disorganization. At any rate, the real settlement of contradictions here too appeared only as a result of intercourse and a greater or smaller mutual penetration of the separated systemic complexes.

What then is the mechanism which is able under contra-differentiation to bring about a resolution of systemic contradictions? What precisely are the methods through which it is achieved? The investigation of the question should evidently be started from simpler cases and not from such complex ones as the preceding examples. The point concerns simply a conjunction among those parts of the system which became heterogeneous. What then,*in general*,can produce conjunction among heterogeneous complexes?

The simplest heterogeneity is that which can be expressed in numbers, i.e., a quantiative heterogeneity. Let there be two drops of water in which ordinary salt is dissolved—sodium chloride; but one of them is a three-percent solution, the other, one percent. Merge the two together. *Quantitative equalization* takes place. This is the first thing that can be expected with any conjunction. Is such equalization the basis for resolving systemic contradictions?

Yes, initially it is; and there are many cases where quantitative equilization plays a very important role. Let us take a few illustrations.

As it is well known, the vital activity of each cell is accompanied by a discharge of products which it does not need or which are harmful and poisonous to it. But the cell cannot always discharge all substances of this kind, and some of them may accumulate in it; in small amounts they are not harmful to it, but beyond a certain level they begin to interfere with its functions, weaken and poison it. Let one of these products become perceptibly harmful for the cells of a definite species, starting from the quantity of some five units. The two cells of this species copulate and amalgamate: in one of the cells the discharge of this substance proceeds normally, and there is only one unit of it, in the other — badly, and five units have accumulated, stifling its vitality. After copulation and the subsequent division into two, it turns out that there are three units of the given substance in each of them, but it does not poison them now.

Moreover, the weakness in a discharge by one cell and the raised energy to do so exhibited by the other, may also equalize so that both cells will subsequently maintain a quantity of this substance at a harmless level. Besides, if for a given substance the second cell made it possible to overcome the vital contradiction, then for any other substance the first may do so in its turn, thus supporting common vitality.

The first cell would have perished from substance A, the second from substance B; both are saved through contra-differentiation. Why? Because they have solved the organizational problem which is posited by the *law of the minimum.* Their fate is determined by the *least relative resistances,* — and the greatest resistances, which are present in other respects, cannot impede this. But they have mutually equalized their least and greatest resistances, and brought them to some "average" magnitudes which now replace the former least resistances.

Such is the general, elementary solution of the problem for overcoming the law of the minimum; its method reduces to the raising of the least at the expense of the greatest through conjunction. The method is, of course, applicable only inasmuch as, first, this conjunction is possible, and, second, it does not lead to such a basic reconstruction of the system that the former least and greatest resistances are not now being equalized but are generally losing their effect.

Thus, assume that there is a rail which is able to support in one of its parts the weight of 1,500 poods without breaking, and in another — only 500 poods. In order to conjugate both parts, it is necessary to bring them into an easily mobile plastic state which they do not have under the given conditions. This may be achieved, for example, through melting. It is then possible to expect the average around 1,000 poods, which will be the least resistance at the same time. But the melting itself may, depending on the temperature and the flow of oxygen, etc., significantly change the structural properties of steel, and then the result will be quite different.

The speed of a squadron, as we know, is determined by the least of the speeds of its separate units. If it were possible to "conjugate" fast vessels with the slow ones by means of towing chains, then the least resistance would be raised. Something similar is presented by the "riding infantry," which permits the combination, to an certain extent, the speed of an attack peculiar to cavalry with the strength characterizing the infantry.

Sexual cross-breeding represents a method of contra-differentiation which was worked out by nature; it is also widely utilized by man, equalizing individual and racial properties and sometimes even the properties of species. Thus, for example, animals which are very strong and of great endurance, very easy-tempered with a sure foot and free from nervousness are necessary for transportation in mountainous regions. The horse is strong but nervous and has comparatively little endurance; an ass is free from nervousness and has endurance, but, because of its size, is not as strong. Their cross, the mule, combines all the necessary qualities. But, of course, the combination does not always give simple results; sometimes it brings about completely new and unexpected structural changes; sometimes its products turn out to be unstable from the very beginning, so that, for example, between species which are no less close than the horse and the ass, cross-breeding does not work at all.

Let the two drops of water, which have served us as the first illustration, have not just one kind of salt in various proportions, but two different kinds dissolved in them. If one of them, let us assume, is the same sodium chloride and the other calcium chloride, then the process reduces as before to the equalization of solutions in half proportions of this and the other salt. But if one is calcium chloride and the other sodium carbonate (soda), then something else happens. A sediment in the form of white powder, carbonaceous lime, which is identical in content to chalk is discharged from the water; and the sodium chloride again remains in the solution, and also the remainder of that of the two former salts which was in comparative excess. Why did it happen in this way?

Contemporary theoretical chemistry accepts that with the encounter of two different chemical formations their elements enter into all sorts of combinations; but from among them only the stable ones are retained; others, unstable, immediately disintegrate. In other words, all these combinations become the material of positive and negative selection. In this case all sorts of combinations had to be formed from the atoms on hand; but one of them was immediately, with its formation, secured by selection, because it was directly torn away from the sphere of subsequent interaction, and this means, also from subsequent changes. This calcium chloride, which is not soluble in water, drops out from it in the form of a deposit. Other unions continue to arise, disintegrate and regroup in the whirlwind of reactions; but as soon as particles of chloride again appear among these regroupings, they also drop out, and are thereby secured, etc. It is clear that the process continues in this way until the entire material for this union has been exhausted; subsequently, the selection of the remaining groups continues until the stable dynamic equilibrium is reached. It comes about when the remaining salts and their ions are distributed in such proportions that the disintegration and formation of each new combination occurs at the same speed, so that both of them are mutually covered.

The second moment of contra-differentiation is before us here, the moment which often reduces the role of the first quantitative equalization to zero. Namely, *conjunction provides new material for regroupings and their selection,* i.e., generally for the structural transformation of the entire system.

If, in the above example, the presence of two simple chemical combinations in the two drops of water was sufficient to give a start to a series of such complicated processes of selection and to such new structural correlations, then imagine the richness of the material which, for example, is provided for selection by a sexual conjunction of two living cells. It can be assumed that the basic organizational meaning of conjunction is contained precisely in this second moment and not in the elementary equalization — although it also may, as we already mentioned turn out to be useful for the preservation of life. Of course, it is necessary to accept beforehand that from this rich material of new combinations a significant majority will always be unfavourable. But life reproduces itself by propagation in countless copies not in vain. Let only very few combinations turn out to be successful, and they will be preserved and sustained by subsequent propagation.

The simplest form of sexual cross-breeding is copulation or "conjunction" of unicellular organisms: bacteria, amoeba, infusorians, etc. It was intensively studied during the last decade. The experiments of Woodreff with the infusorian *Paramoecium aurelia,* which normally conjugates through several tens of generations, showed that under definite conditions it can get by without conjunction over the period of several thousands of generations and remain quite viable. These conditions were as follows: after each division of the cell, Woodreff took one of the two and transferred it into a fresh nourishing solution which was frequently changed; in addition, all the necessary measures were taken in order to remove products of its vital activity poisonous for the cell. It is clear that an ideal environment was being created with almost a complete removal not only of harmful influences, but even of the influences producing changes in general. In the usual everyday situation the descendants of the cell are surrounded by such influences, varied influences for separate individuals at that, and are inevitably subjected on this basis to systemic divergence, differentiation. With this, even if each cell adapts itself successfully, its viability will be inevitably lowered in the sense of *narrowing:* it will have special adaptability to a definite environment and definite external influences, but not to others; furthermore, of course, a continual success in this living struggle should not be expected. It is exactly such a differentiation and its unfavourable feature that make contra-differentiation necessary,in general,for the solution of the problem. Insofar as the problem is removed in the experiment of Woodreff, its solution becomes unnecessary. In reality, the conditions giving rise to it are probably not completely absent here, but are only considerably weakened – a hundred and, perhaps,a thousand times;and they must be accumulated over a correspondingly longer period of time for the vital necessity of a solution to arise.

But what does the solution really consist of? Careful observations of Jennings revealed that after conjunction the average mortality rate of the same infusorian was *raised*, and the propagation was *slowed down.* However, this as if unexpected and paradoxical result, suggesting at first sight a thought about the harm of conjunction, in fact fully corresponds to what we should expect tektologically. Conjunction provides a rich material of new combinations for selection; but, as we have already noted, a significant majority of these combinations and appearing changes must be accepted beforehand as *unfavourable,* because the process proceeds elementally and unsystematically. Therefore, it is not unusual that for an individual cell conjunction is frequently more harmful than it is useful and, at times, probably even quite disastrous. But it is absurd to admit that a complex reflex with whose aid conjunction is accomplished has existed and evolved especially in order to harm life. What is, on the average, bad for separate *individuals,* may, on the whole, be useful for the *species.* And this is revealed in other experiments of the same Jennings. He grew numerous generations of *Paramoecium* by separate lines, so to speak, carefully removing the possibility of mixing the various lines, and selecting in each of them strictly identical individuals. From these parallel series, conjunction was permitted in some of them; in others it was not permitted. Both were subjected to a harmful influence in the form of an unusual for them rise in temperature of 32° C. It turned out that from the 51 individuals of the pure *non-conjugating* lines, 35 perished and 16 survived, i.e., 69% against 31%; from the 47 individuals of the *conjugating* lines 11 perished, i.e., only 23% and 36 survived, i.e., 77%. Thus, in the second case, the viable stability under a destructive influence turned out to be *significantly higher:* the percentage of those who survived was 2½ times greater,and of those who perished 3 times less.

Jennings himself concludes that under favourable conditions of life conjunction is not necessary, but under unfavourable conditions it is a very important and valuable adaptation. It provides more space for changes in viable forms and their selection: the conjugating lines are more flexible and possess a richer material in each individual member of the line for evolution.[1]

Thus, conjunction raises mortality and slows down propagation *for individuals*; *for races* it raises the viability in the struggle with destructive forces.

No conjunction whatsoever– not only this, biological, but none whatsoever, in the most general tektological sense of the word – can occur without an expenditure of activities. The concern is with the reconstruction of the system, in the midst of selection of its elements, their relationships and groupings. The selection is initially, of course, as always in nature, negative, in particular when the reconstruction follows, as it does here, a type of a crisis. The merging of the former complexes, however partial, means an inclusion in its content of a series of new combinations, alien in origin, and not adapted to this content and structure. The operation of the negative selection must be very intensive here.

Such an operation, with a waste of vital activities, is inevitable with the conjunction of cells. This waste may be great or small; benefits of a union are also varied in degree and character. The general result of reconstruction may be a plus or a minus, a rise in the viability of the product of conjugation or a fall in it. With the enormous physical and chemical complexity of the cell, it is not surprising that the result is more often negative, and that the average mortality rate grows. But we know the tektological role of the negative selection: it leads to greater organizational connectedness and harmony at the price of destruction; and in those cases where its destructive function does not go beyond a definite limit, the rise in structural stability is capable of surpassing, at times quite significantly, the fall in quantitative stability, i.e., the general sum of systemic activities.

The stronger is the divergence of conjugating complexes, the relatively greater must be the internal contradictions of the conjugated whole, and this means the greater is the waste of activities. But this is only one side of the story; the other is no less important. The weaker is the divergence, the less energetic is the reconstruction, and the less able is it to produce new organizational combinations and adaptations. Evidently, there must exist an "optimum," i.e., the best correlation, in this case – the most beneficial level of divergence of the cells-individuals, under which the most favourable results for life and the evolution of species arise. Since divergence in the posterity of each cell grows with each generation, then in the ordinary situation of a given species, after a certain definite number of generatons, an advance must be made towards this approximate optimum in divergence, which is taken again, of course, as an

[1] Jennings thinks that the slowdown in the subsequent division of cells is also advantageous because each act of division temporarily weakens them and, thus, under unfavourable conditions is especially harmful. Tektologically, this slowdown, if it turns out to be constant and necessary, may be understood as follows. The cells which survive after conjunction. possess now, evidently, a higher structural stability, but the division of the cell is, in any event, a *structural crisis;* naturally, the growth in structural stability may postpone the crisis.

average for the mass of individuals. Natural selection must adjust the evolution of a corresponding instinct or reflex to this optimum, working out a definite periodicity of conjunctions or copulations. For some unicellular organisms such a period may be several dozens, for othrs, several hundreds of generations.

The same features may be traced in all other cases of contra-differentiation: the role of negative selection, although unfavourable for a quantitative stability of forms, is especially favourable for their structural stability, provided the destruction does not proceed too far; it is significant for the result of conjunction under a very weak divergence, and has a growing probability of unfavourable or even fatal outcome under the conditions of an excessively strong divergence. Here are a few examples.

History tells us about the price of efforts, sometimes bloodshed and destruction of the products of labour, with which the unification of state organizations and amalgamation of nations and tribes was bought, even those that were quite close to each other. As was already noted, from the tektological point of view the distinction between "forced" and "peaceful" amalgamation is not essential; the difference is only in quantity and intensity of disingressions; but they are always present. Even the most peaceful mutual assimilation of tribes living side by side goes through countless frictions and petty collisions, arising on the basis of diverging interests and mutual misunderstanding, i.e., in essence, the varied structure of the amalgamating socio-cultural complexes. The greater is the divergence, the greater the totality of disingressions can be expected, the more probable is the "forced" type of contra-differentiation through a direct struggle.

In a similar way, the unification of party, scientific or cultural organizations, although already bound by common elements of the social environment, kinship of social content and their vital tendencies, always costs quite a large sum of efforts and is always accompanied by the removal of some elements. The former means an expenditure of activities on mutual adaptation of the amalgamating organizations; the latter means a direct loss of activities through negative selection of those combinations which are not adapted to the new structure. Thus, for example, under the amalgamation of political parties or functions some programme and tactical elements are sacrificed in order to escape internal strife; equally, having become superfluous or inconvenient, some particular organs, posts or special centers are also abolished; usually, some members of the organization, who are unhappy with the amalgamation or able to hamper it, are also thrown out. Under an excessively great divergence of the conjugating complexes, the waste of activities and new contradictions can turn out to be so large that the viability of the whole will be lower and not higher than before; and the whole business will end in sickness or a reverse decay.

Marriage is a partial psycho-physiological conjunction of two individuals and the formation of a more complex whole— the family. And here the waste of energy of both sides on mutual adaptation always exists, only its magnitudes are quite different. Usually it is more than compensated by the positive results of marriage, but sometimes the waste of energy reaches such an extent that the whole becomes unstable, and the conjugated complexes separate again with a lowered viability, or even become crippled. This case corresponds to their excessive living divergence. The differentiation which is too weak, makes the connections, so to speak, "empty" and fruitless for the development of both sides. However, thanks to the uneven evolution of various systems of the organism, in particular of the nervous and sexual systems, that marriage which is barren and empty to the personal lives of spouses may be different and more successful in the sense of creating posterity; but equally well the reverse is also possible. This dual character of marriage, which includes the conjunction of two psychic personalities for everyday collaboration on the one hand, and the two sexual cells for the conception of new life, on the other, gives rise to many contradictions and incompatibilities in contemporary mankind; and it will continue to give rise to them until scientific thought and scientific technology do not fully master the conditions of embryonic elements and the harmonious development of the human being from the very conception.

It is necessary to note that the operation of negative selection generally appears particularly clearly in sexual propagation. When significantly separated varieties of the same species are cross-bred, for example, when various strains of domestic pigeons are developed by artificial selection, then there occurs a return to the original, undifferentiated type— the wild pigeon, from whom these strains originated. Consequently, the whole series of elements and groupings, acquired in the process of divergence and secured in each strain by heredity, is rejected; the acquisitions of one party to the conjunction are not suited to the structure of another, and they are destroyed because of this contradiction, but also conversely.

The "contra-differentiating" role of sexual propagation is particularly clear here. As we saw, it does not only raise the viability which was weakened by divergence, but also counteracts, in general, the unrestrained divergence; and this is necessary because such a divergence, constraining the life of each form, sooner or later would have led to a downfall on the basis of one-sided evolution, adaptability to limited, special conditions and an impossibility to adapt to changes in them. It is clear why sexual propagation is especially necessary to higher organisms and is less important for the lower ones: the more complex are the forms, the easier and more significantly the divergence in descendants takes place and unfolds.

If we pass to higher fields of human creativity, then we will find exactly the same correlations and regularities. How is the simplest generalization created, for example? By means of the conjunction, usually, of the whole series of related notions. At the same time, the elements of *distinction* are removed from the organized whole, i.e., namely, the diverging, incompatible elements.

The Marxian principle of scientific socialism was the result of a characteristic contra-differentiation. The socio-revolutionary tendency at that time was sharply differentiated in two directions: the ideal "communism" in the heads of utopians, representatives of the most advanced intellectuals passionately sympathizing with the working masses, and the labour movement, which was shaped in practice by the vaguely formed ideas in the heads of working masses about a general struggle for a better life. In the synthesis of Marx, both were subjected to purification from the whole series of former elements. From the idea of the labour movement hostility to machine technology, professional shop-narrowness, and representations of the grossly material character of its goals, of elemental spontaneity of action were removed.. The ideal of communism was freed from moral and philantropic colouring, from a connection with the faith in a possibility of realizing this ideal by persuading higher classes of its justice, and from the usual religious admixtures, etc. The whole turned out to be incomparably more harmonious and viable.

The correlations are of the same type in the inorganic world. All conjunctions of material bodies, from the astronomic "marriage of the worlds," i.e., the collision or close rapproachment of stars and nebules, to a simple merging of two drops of a liquid, are accompanied by a decomposition of atoms, in a gigantic or insignificant quality, and a waste of energy in radiant form or through its entropic dissipation. And everywhere, consequently, reconstruction of forms proceeds on the basis of negative selection, simplifying and harmonizing them through destructive processes.

Contra-differentiation is infinitely spread in nature. We saw its examples at all levels of organization. We will not note that to it, in essence, must be generally attributed all cases of ***equalization of tensions***: the equalization of temperature between bodies through radiant exchange or heat conductibility, the equalization of mechanical pressures through waves of pressure and expansion, the equalization of electricity in conductors through a discharge or current, and the equalization of the content of liquids and gases through diffusion, etc. And here, as in any contra-differentiation, a simple quantitative equalization is only the first moment; the concern may be reduced to it alone only in scientific abstraction; in reality, however, the second moment always appears after it: structural changes in the selection of new material of combinations.

The idea of the connectedness of all that exists, "the univeral ingression," presents the universe accessible to us as an infinitely unfolding differentiated system, and all the processes of equalization occurring at each of its points as a continuous contra-differentiation. This feature of nature has been studied much more than the mechanism of nature's original divergence; it is the contra-differentiation which serves as a basis for the various theories about the approaching destruction of existence, through its running down in indifference and in universal equalization, thermal or any other. But to this day science does not know how those differences were created which are now being equialized, how those atoms were formed which are now being decomposed, and what are the bases of differentiation of the universe itself. For as long as this is so, any constructions of maximum contra-differentiation are quite arbitrary.

5. The Tektology of Struggle Against Old Age

Let us now attempt to apply the outlined regularities to a particular, but vitally interesting question concerning methods of struggle against old age. Up till now this was considered to be a question of the special applied sciences: medicine and hygiene which lean on the special theoretical sciences– physiology and pathology. But if old age, as was pointed out earlier, is a special case of the general organizational fact– contradictions of systemic divergence, then the question can be posited tektologically; and this statement is always the most broadly generalizing, i.e., the most useful for the elucidation of *methods* which are used to solve the problem.

The old, specialized scientific thought approached the problem in the following way. It endeavoured to analyze the phenomena of old age as any other illness, and subsequently searched for the corresponding medicines against old age and a preventive diet. Thus, some saw the basis of the process in the damage to circulation of the blood– the loss of resilience in blood vessels and calcification of their walls, and directed against this hygienic and medicinal measures; others, ascribing a special significance to the loss of some internal secretions which are related to sexual life, endeavoured to substitute them with supplements from outside, by means of extracts from seminal glands, etc.; the third, taking as the point of departure chronic poisoning of the organism by poisons of the intestine, worked out a special food diet against it, etc. In all of this, undoubtedly, there is a lot that is true, and valuable conquests have already been made by following these paths. But all such methods are limited in one sense: they are, in essence, *only partial.* Old age, in its nature, is not a partial damage of the organism, and even not a simple sum of partial damages, even though there may be a great number of them. It is a tektological disease, so to speak, embracing the entire structure of the organism: partial methods against it, in medical expressions, are only palliatives, i.e., they are not the means of struggle with the desease as a whole, with its base, but only with its separate "symptoms" and special manifestations. And the creators of the above mentioned methods themselves generally acknowledge this, thinking that they fight against a "premature" old age for a "normal," "natural" old age; and such is, in their view, the latest old age possible under the best living conditions. And this old age is now understood as something irrevocable; as its basis they consciously or unconsciously, latently or openly, accept, in essence, a metaphysical basis, some "exhaustion" of the vitality in elements of the organism– as though this vitality was a special, definite quantity of force put into the organism, and not as a constantly changing relationship between its activities and the activities destroying it.

From the tektological point of view, another *general* statement of the problem is also possible *in principle*, which should be obvious from the preceding. It concerns the *solution to contradictions of systemic divergence*. The method— not just partial but holistic— is also known to us: *contra-differentiation*. However, the question is how to apply it.

If in our investigation of the question we will be concerned only with a separate organism, then immediately, apparently, insurmountable difficulties will arise. In the first place, conjunction gives generally positive results only up to a definite extent of divergence; when the divergence goes beyond this level, blending turns out to be quite disharmonious, and is accompanied by quite a large dissipation of activities; and even more— the matter reduces to the inevitable failure, to a complete downfall and destruction. In the organism of man, the level of differentiation of cells of various tissues is incomparably greater than that divergence which exists among the cells of one species capable of conjunction, even of such comparatively highly developed species as, for example, infusorian *Paramoecium*. To a biologist it is clear that, for example, conjunction of the nerve cell with a diametrically striped fibre of the muscle would be a vital absurdity. Moreover, any similar contra-differentiation would inevitably and radically disturb complex complementary correlations— the base of the vital stability of the organism; and problems of this type are generally solved only inasmuch as the necessary complementary connections are preserved subsequent to conjunction.

In the second place, purely technical direct conjunction of heterogeneous tissues of the organism is also infeasible without their destruction, because all these functions are firmly connected with their role in the organism, and it, in turn, is secured by the skeletal system (bones, cartilages and conjunctive tissue).

If so, then what path should be taken in search of a solution? The one which is sought for and found by our great teacher in tektology— Nature. Nature, when faced with the problem of a similar type, expands the range of givens: it does not limit itself to one individual, but takes two or even more. Copulation and conjunction of unicellular organisms and the blending of sexual cells in higher organisms are precisely the modes of struggle against the negative feature of systemic divergence. Individual narrowing of viability and its individual decay are surmounted through the combined forces of individuals; and what is achieved is called by some biologist, not without foundation, as the "immortality of protoplasm."

Conjunction between human beings is known so far in two forms. The first is sexual, as with other organisms; it is, evidently, quite partial. Nevertheless, it also does not in fact reduce *only* to an amalgation of two cells from some hundred thousand billions of cells forming the parental organisms; this is seen in the facts of "reflected heredity," when the woman having had children from a first husband, continues to bear children resembling him in another marriage.[1] The second is the interaction of knowledge and conjunction of experiences, by means of speech, mime, art and other modes of expression and perception which have been worked out in a series of functions of the nervous-muscular apparatus. This conjunction, however, is not only "psychic," as its results show under the repeated and long intercourse which exists, for example, between spouses. Thanks to the dependence of all organs and tissues on the nervous cerebral activity, after 15-20 years *of joint life* an external physical likeness between the spouses *is also* acquired, which on the average may be no smaller and sometimes even greater than the usual likeness between brothers and sisters.

Medicine has already been successful to add to these two a third form, still *one-sided* and quite *partial,* but nevertheless a direct physiological conjunction; these are various *graftings* of organs and tissues: graftings of skin in the case of severe burns, blood transfusion, infusion of blood serum, etc. The experiments of Alexis Korreli, for example, which involve grafting of sometimes the most complex whole organs in the case of animals, open the widest perspectives in this direction.

Practically, such graftings represent a solution to the familiar type of problems— "of definite resistances." In a certain part of the organism, or in a certain part of its functions, there are insufficient relative activities-resistances; they must be, so to speak, supplemented from outside: under a great loss of blood it is possible, in order to avoid the death of the organism, to replenish it with the blood of another man; to avoid the danger from microbes and poisons, it is possible to inject a serum from an "immunized" animal which paralyzes them, etc. From this statement of the problem flow both the *one-sidedness* of the conjunctive act: a blood transfusion from one man to another, but not an interchange of blood, not a general mergin of it— and its *partiality.*

Contra-differentiation has a different character. It can be considered as the solution of a general problem, the problem of "indefinitely-changing resistances." But, of course, the problem of struggle against the old age belongs exactly to this type. The solution of the manner of the conjunctive renewal of the living cells outlines by itself. But these cells, with their colloidal, semi-liquid structure can be easily merged physically in their entirety or through a partial interchange of their living tissue. Two human organisms, with their external skeleton— skin, and internal— bones and cartilages, etc., are not able to merge so simply. What then is possible here? With modern scientific technology, it is quite possible to have a straight, direct conjunction of those tissues of various organisms which have a liquid form, i.e., blood and lymph. These are the tissues which compose the internal conjunctive environment of the organism and maintain its chemical unity through a continuous interchange with all other tissues. Technically, the problem must be reduced to a somewhat complicated operation of

[1] More will be said about this form of heredity later.

blood transfusion -- to a simultaneous, interchanging transfusion from individual A to individual B, and from B to A, with neither one nor the other sustaining quantitative losses of blood.

What can such an operation produce? Of course, it would be naive to assume— as some chemists thought in the old days— that young blood simply, so to speak, is able mechanically to rejuvenate an old organism through an excess of "vital force" contained in it, and that the old blood in just as simple way to age a young organism. It would be not less erroneous to see in it simply a nourishing liquid. Blood is a living tissue; it is very complex and possesses an enormous organizational role. Leucocytes live in it, carrying on their struggle against internal enemies— the microbes; in its serum anti-acids— "antidotes"— are developed against microbes and other poisons; "hormones" circulate in it, the internal secretions of the whole series of special glands, regulating in many respects the life of an organism. Being an inner environment of the organism, the environment for all of its organs and tissues, blood is "correlative" with them, and as any other environment it carries their structural stamp as their vital complement. Therefore, blood is, as precise investigations show, *individual* in its content, i.e., different in different organisms. It cannot but influence all organs and tissues, as all of them influence it. With its transfer from one organism to another, for example, "immunities"are inevitably transmitted to a certain extent— i.e., an ability to resist various infections; leucocytes are transmitted with a certain degree of fighting ability; hormones are transmitted with their regulating tendencies, etc.

The most probable conclusion is as follows. The conjunction of liquid tissues of organisms must have not a partial, but a *general* influence on their viability. There are reasons to believe that young blood, with its materials taken from young tissues, is able to help an aging organism in its struggle along the lines where the organism already suffers defects, i.e., exactly where it "ages;" of course, to what extent it can help, can only be shown by experience.

But are there any bases to assume that old blood must "age" a young organism? This has a very small probability. The strength of youth consists in its enormous ability of assimilation and transformation of any material. It can cope quite easily, as we know, even with a direct loss of a significant quantity of blood, restoring it quite fast. It can be expected then that, apart from cases of infection, it will also abe able to cope with the material of weakened, deteriorated blood; moreover, in the older or generally deteriorated blood there must exist, nevertheless, also such elements for evolution which were absent from the better blood. Besides, there is no reason to limit this conjunction to a combination of old and young, or strong and weak: the broadening of life here depends generally on *going out beyond the limits of individuality*, the addition of an individual to an individual for a viable agreement.

Some important particulars spring up by themselves. Let, for example, certain toxins accumulate in one organism due to individual conditions of its conception and development, which cannot be fully removed from its tissues or paralyzed by its blood, in another organism, however,— other toxins. Then an interchange of blood must lead to a deep cleansing and refreshment of the organism, to a liberation of the organism from specific internal poisons harmful to it.

Further, the transmission of immunities against various diseases may be achieved. With an interchange of blood this is possible on the widest scale, because the quantity of transfused blood may be quite large on both sides, composing a significant part of its total quantity. Besides, a transmission should be expected of not only those immunities which are acquired through illness or immunization, but also of others whose transmission was not possible so far— the immunities which depend on age (in mature organisms against some illnesses of children, and conversely), and heredity, etc.

But, perhaps, the main acquisition will turn out to be a positive increase in the sum of elements for evolution. We, to be sure, do not yet exactly know the extent to which blood and lymph serve as carriers of organic properties embodied in the remaining organs and tissues. But from the organizational point of view it is unthinkable that with a continuous and close intercourse with them, these liquid tissues did not reflect their structure and content. There is a direct indication of this: if the *heredity of acquired properties* exists— and, apparently, it has to be acknowledged, to a certain extent, by contemporary science— then through what other environment, if not through blood and lymph, the necessary, so to speak, "imprints" of the changes which have taken place there could be transmitted to embryonic cells from other parts of the body.[1]

It is clear that the indicated path is full of difficulties and even dangers: we know that in other forms of conjunction a combination of individual complexes is not always beneficial, not to speak of the possibility of transmission of illnesses, etc. But, evidently, what follows from this is only a necessity for a systematic investigation and the careful design of experiments, beginning with animals. Incidentally, such experiments have technically already been made with animals, but for quite different purposes. In order to clarify the impact on the organism of internal poisons, products of overexhaustion, etc., cross-blood circulation was attempted— carotid arteries of two dogs were artificially connected so that the blood of one fed the brain of another, and conversely. And those, who carried this experiment out, apparently did not even notice that at the same time they were grafting the living

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[1]The coincidence, of course, is not accidental and the fact remains that the transfusion of blood which does not harm or destroy blood bodies, is possible, generally, within the same limits as those of a successful sexual crossbreeding, i.e., *between animals of the same kind.*

tissue on a large scale: almost half of the blood of an animal (under a sufficiently long experiment) was replaced with foreign blood.

The individualism of the contemporary scientific thought is the main reason why research to this day does not follow the path which opens before us an enormous field of work and perspectives of unprecedented conquests; the idea of deep physiological interchange of the life of individuals must appear not only alien but quite repulsive to it. Of course, evolution will surmount this obstacle.[1]

6. Convergence of Forms

Convergence of forms has a different organizational meaning than contra-differentiation and also a different origin. Both can be illustrated in the technical process of casting. Any given quantity of metal, and even different metals or other substances possessing a definite fusibility, having passed through one and the same casting cavity acquire an identical surface embracing identical volume— quite a complete geometrical convergence. It will also occur in cases where not one and the same casting form is applied, but several identical forms. Evidently, the basis for such facts lies in the influence of an identical or similar environment on various complexes, changing them in a definite way.

In essence, the mechanism is not complex. Particles of the molten substance move in all sorts of directions and spread out in various ways. These movements lead to the filling of the entire cavity; but they stop at its boundaries. There appears a counteracting coupling of hard particles, whose insignificant part is sufficient in order to form a full disingression with the entering activities of the liquid particles. And a full disingression also means negative selection, and on its basis— a tektological boundary. Subsequent hardening of the liquid, depriving its particles of mobility, secures this boundary, and thereby, in fact, helps to achieve the technical purpose of casting. Repetition of this operation with new quantities of the molten substance produces new copies, similar to the first ones.

This can be generalized in the following way: *convergence is the result of a similarly directed selection on the part of a similar environment.* The difference from contra-differentiation is quite clear: there divergence or its negative consequences are paralyzed by direct conjunction of the diverging forms themselves; here such a conjunction does not exist; similarity of complexes is determined not by their own intercourse, but by their relationships to the environment.

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[1]For some technical details and theoretical considerations relating to this question see Tektology, V. I, pp. 142-148.

The role of a "casting form," of course, in various senses and degrees, can be performed by any definite environment. Thus, mammals, such as the dolphin or the whale, having moved from land into the water, acquired many features common with the body of the fish; this is a result of the water environment. Water presents, for example, great mechanical resistances to movement; in order to overcome them, selection has worked out an external form of the body of these animals as if using the body of fish as a model, which had been worked out previously by selection under conditions of the same environment. With higher vertebrates, such as man, and with higher mollusks, such as the octopus, the eye structure presents an enourmous likeness, despite the complete independence of evolution of this organ in both these branches of the animal kingdom. Convergence was determined here bya common "optical" environment: adaptation to etheric waves within definite limits of their length. With some species of ants a technique of cattlebreeding is observed, and even that of farming, which is fully analogous to human techniques: both were adapting, although on a different scale, to animal and plant environments as a basic material of vital exploitation.

Biological sciences deal with facts of convergence at each step. There, they have received the common designation of "analogies," and are contrasted to the phenomena of "homologies." For example, comparative anatomy recognizes as "homological" the hand of man, the foreleg of a horse, the wing of a bird and the fore-fins of fish. These organs are homogeneous in origin, having evolved from a common beginning; but they have lost a great deal of likeness, due to different living applications, and, consequently, various lines of adaptation to the environment: homology, consequently, expresses a divergence of forms. Analogous organs, on the contrary, are of a heterogeneous origin; they became similar due to like functions; such are, for example: the eye of a man and that of an octopus, with their parallel parts, and sensible layers of retina arranged in a reverse sequence; or bones of the skeleton of vertebrates and the "bone" of the cuttle-fish; or the wing of a bird, with its skeletal foundation, and the wing of a butterfly, which originated from a fold of chitinous integument. The water plant *Caulerpa* presents a gigantic cell (of several inches in dimensions); it is possible to distinguish in it quite clearly the root, the trunk and leaves; but these organs are, of course, analogous to the roots, trunks and leaves of higher plants composed of countless cells. It can also be noted that the breeding of aphids by ants—cattle-breeders and the cultivation of mushrooms by their American relatives-farmers are analogical only, and not homological with the cattle-breeding and farming of people. The "kinship of functions," which explains all analogies in this sense, arises from a similar relation to the environment; and the same mechanism of selection, which along the line of the divergence of forms makes unrecognizable their original kinship, may create a striking illusion of such a kinship along the lines of convergence.

In the inorganic world, convergence of forms is no less prevalent. So, all contemporary cosmological theories admit the possibility of a quite independent formation of similar universal forms, namely— as forms of equilibrium in the cosmic environment. Saturn with its rings finds a full external analogy in planetary nebulae; and the physical experiment of Plato reconstructs the same architecture in the rotation of an oily sphere in a balanced mixture of its liquids. Star clusters of the Milky Way, to which also belongs the Sun, are similar in shape not only to other star clusters, but also to some real mists. The atmosphere of Mars and its polar caps are, according to present information, qualitatively similar to the atmosphere of the Earth with its deposits. The lingering motion of a solid body in the air produces sound waves; the lingering motion of an electron in ether— electromagnetic fluctuations, or light fluctuations of the same type; these vibrations present an enormous likeness from the point of view of mathematical analysis. The structure of atom is, according to contemporary views, analogous to the structure of planetary systems and, in particular, apparently, to the same Saturn with its rings. Such examples can be cited without end.

Generally speaking, under what conditions are similar relationships to the environment which direct the operation of selection towards convergence possible? Of course, for this it is also necessary to have the presence of some prior *organizational homogeneity* of complexes: the more varied is their organization, the less probable is the existence of an identical relationship to their environments. People and ants were able to "agree" on methods for procurement of food because both are collectively-labouring animals; the convergence between ants and termites is evident even more in the independently created architecture of their dwellings, because ants and termites are not only homogeneous in social aspects of their life, but are also closely related in the structure of their organisms. Atmosphere which is similar in many respects could appear on Mars and on Earth, after a cooling of their liquid condition, only because these two planets were formed from a homogeneous material, as children of the same nebula.

True, this structural homogeneity appears to be quite remote in other cases: such are the examples of vibrations engendered in the air by the molecular content of a body, and in ether— by electrons, or the example of the rings of Saturn, rings of nebulae in interstellar environment, and the oily ring in the liquid environment of Plato. But convergence in such cases spreads to the most general, so to speak, principally-architectural form, expressed by an algebraical or geometrical scheme; and the corresponding level of generally structural kinship can also exist between the most remote systems in other respects: the very possibility of universal tektological generalizations is based on this.

Such generally-tektological convergence can be called "formal," in contrast to a deeper convergence— we will denote it as the "real" convergence— appearing in our initial examples, where the concern is with systems of common origin which later diverged in the process of evolution; such as the fish and water mammals, or Earth and Mars.

The real convergence has a closer relationship with contra-differentiation than appears at first sight. Let us consider this relationship in the following illustration. The children of different social classes and groups, different upbringing, abilities, character and temperament are gathered into the same school. They leave the school with some knowledge, implanted convictions, mental, volitional and physical habits common to all of them. If we compare two series of graduates, divided by one generation of students who have not had direct contact with each other, then the community between them which is created by the school presents itself as a typical "convergence:" it is the result of the influence of an identical environment which is formed by the pedagogical institution with its surroundings, teachers, programs, textbooks, and customs, etc. If, on the other hand, we take students of the same generation, then they will have a greater community among themselves, but its origin will now be twofold: for one of its parts— the same as in the previous case; for another— on the basis of a direct contact among students; i.e., convergence plus contra-differentiation. However, this was possible only because we mentally separated students from the school, and opposed it to them as their "environment," as something external. But it at once becomes evident to what extent this division is conditional. The pedagogical process can be considered with full justification as a vital interaction of tutors and the entire institution with the students, i.e., as a conjunctive process. That one side during this process influences the other more, does not, of course, change anything, because conjunction is not necessarily characterized by uniformity in mutual changes on both sides; in fact such uniformity never exists. Evidently, with such a statement of the question, the entire "convergence" reduces now to direct conjunction of heterogeneous complexes, i.e., to the same contra-differentiation. But if this point of view is subsequently applied to students of various school cycles, then the following will happen: the changing generations of students, though not interacting directly, go through a conjunctive intercourse with one and the same organization— the given institution; but it is precisely from this institution that the students acquire a community of knowledge, habits, etc.; in other words, this community is also conditioned by contra-differentiation, but only ***indirectly.***

Generally, this relates to any "real" convergence. Thus, the process of casting consists of conjunction of the molten mass with the casting form, i.e., their "contra-differentiation." True, from the chemical point of view this intercourse is very weak, because disingression and boundary are formed quickly; however, some minimal chemical blending and interaction do nevertheless occur; and besides, it should be remembered that conjunction will not cease to be such even when it does not lead to a positive but a negative result, not to ingression but to disingression. Thus, from the point of view of thermal and electrical activities the conjunction is quite complete, and contra-differentiation, even in the sense of anequalization of these activities between the two sides, appears quite vividly. In relation to the spatial form, the mutual influence of both complexes is quite uneven; but even here it is mutual, and becomes quite noticeable with a damage to the casting form after a series of repeated uses; the unevenness of influence, as was already noted, does not change the matter at all. And all the subsequent quantities of metal, which are passed through the same casting cavity, "contra-differentiate" with it, and thereby indirectly contra-differentiate among themselves.

Equally, the influence of the water environment on the fish and dolphin, inducing analogical forms to their bodies, can be considered as an enormous series of conjunctive processes of these vital forms with the homogeneous complexes of activities-resistances of the water: tektologically, the liquid performs here the role of the "casting form" for the moving living bodies within it.

Nature provides an interesting illustration of the principle of the casting form in the so-called "pseudomorphosis" of crystals. Among insoluble sedimentary mineral rocks there is included a crystal of a more soluble substance. The water circulating there gradually dissolves it and carries away its substance, depositing in exchange some other substance which was already in the water in a dissolved state. After a full exchange, the latter looks as if it were cast in the image of the first crystal, forming a "pseudo-crystal" of a completely alien species.

The method of the "reverse casting form" is widely used in technology. Ordinarily, the casting form is prepared in accordance with a model of what is to be cast, by covering it with some plastic, hardening, refractory substance: the same casting of another practical variety and in another direction. And it is curious to what extent the distant in external character processes fall within the scheme of this method. It is enough to point out from the field of scientific technology— the photograph and phonograph. The phonographic recording of sounds represents a trace of sound vibrations of the needle on the plastic mass of the revolving cylinder; this is a mould of various successive positions of the needle corresponding to a "form" which is made in accordance with the model. When the needle follows this trace later, it must again take its former position, i.e., reproduce former vibrations, and this means— the recorded sounds; in this way, the recording performs here the role of a casting form for movements of the needle. The principle of photography is the same, only instead of sound vibrations there are other—light, or more precisely, electro-magnetic vibrations, and the light-sensitive substance of the plate, decomposed by the energy of these vibrations, performs the role of plastic material for the mould.

Human speech and its understanding are structured according to the type of a reverse casting form which is, so to speak, in a fluid state. The sounds of words represent, when compared with a phonograph, as if engraved in the air trace of nervous-cerebral vibrations of one man; this trace immediately performs a reversely-forming role for similar vibrations in another organism. The same scheme, in all its complexity, can also be discerned in any other symbolism— writing, art, science. . .

The above mentioned pseudo-morphism of crystals can serve as an illustration of the reverse casting form in nature. The scheme is complicated here by the fact that the removal of the forming model proceeds quite gradually, and that its replacement by the material of a new casting takes place at the same time. An even more interesting illustration is that of a "reflected heredity," when children of the second spouse are sometimes similar to the first spouse. Whatever is the mechanism in all its concrete complexity, its tektological scheme is almost always the same. The reproductive apparatus of the young mother turns out to be sufficiently plastic for children of the first father to have left an imprint in it, a trace of some pecularities of their structure. According to this imprint new children are subsequenly formed to a certain extent, but now from another father. A kind of "hardening" of the originally soft form, perhaps, occurs here: it is well known that with time the organism becomes less plastic.

We have shown in a number of examples that any "real" convergence is only an indirect contra-differentiation. This may appear to be not applicable to "formal" convergence. Here the environment, determining the formation, may be quite different— for example, the interstellar environment on the one hand, and a mixture of liquid in Plato's experiment on the other; moreover, the complexes which are being formed by this environment are of different origin. Nevertheless, a *similar relationship* of complexes to their environment is present. And the very possibility of such a similar relationship means the existence of a *tektological unity* of forms, as well as of their environment.

But what is the origin of the tektological unity itself? The more science develops, the more it is revealed that this unity is nothing else but the result of a *genetic* unity, that in it is expressed the bond of origin, *although this bond is quite remote. It unfolds to the entire universe of the experience accessible to us; and the formal convergence is being thereby reduced to a more indirect real convergence.*

7. The Question of Vital Assimilation

It is not by accident that almost all the examples which we have used at the beginning to illustrate the possibility of universal organizational forms and laws, and, consequently, also of tektology as a science, were concerned with the facts of convergence. Any complex is contained in its environment simultaneously as both the casting material and as the moulding model; it is determined by this environment in the first sense, and partially determines it in the second sense. Any repetition of forms and, consequently, any observed regularity is based, in the final analysis, on some convergence.

Therefore, the scheme of convergence ought to guide us initially, when it is necessary to explain a still obscure repetition of facts, an enigmatic regularity. From a series of such regularities, the one that is closest to us and the most interesting is *vital assimilation.*

The living organism is characterized as a machine which not only regulates itself but also repairs itself. As the elements of tissues of the organism wear out, the organism replaces them with material taken from the surrounding environment, the "assimilated" material, i.e., brought to a chemical content of these tissues. The "dead" matter, which is taken from outside, is converted by the protoplasm into its vital material, not just any kind in general, but quite definite and chemically identical to the molecules of exactly this protoplasm. Besides, from the hundreds of thousands of species of plants and animals, each is distinguished by its peculiar chemism and content of its proteins, which is different from all the rest,—and in the process of its assimilation, the protoplasm forms exactly these proteins from the same nutrious material from which other species form other proteins. In this lies the basic enigma.

If alien proteins, which are received from outside, serve as nutrients for the organism— for example, when man eats meat of other animals, or fruit, stalks and the roots of plants— then the organism initially, during "digestion," disintegrates these proteins, decomposes them into component parts, which are various amino acids. Subsequently, it reconstructs in the tissues from the amino acids its own combinations, its specific protein substances. As far as the plants are concerned, most of them create at first carbohydrates and then amino acids from carbon dioxide in the air and the ground water with its salts and acids.

So why is different material which is received by the vital protoplasm cast under its operation into specific forms of its own structure? For example, why are amino acids of the disintegrated proteins of our food, from millions of different possible combinations, put together into those combinations which are exactly peculiar to the proteins of our body? New materials in various, changing proportions join the old composition; why does not happen what occurs under any direct blending— contra-differentiation, i.e., changes of this composition into a different, so to speak, interval composition between the old and the new material?

There exists a unicellular animal— the vamp, called acineta. It adheres to some infusorian and draws out its plasm, which flows directly into the plasm of the vamp through sucking tubes and merges with it. But if this were a simple merging, then, evidently, the composition of the acineta would have been deprived of any stability: each time it would have changed into something average between the former acineta and the sucked-out victim. Also our food, although not quite as fast, but no less radically, would have changed our composition. In order to avoid this, it is necessary to accept that in our organism, as in the organism of acineta, the incoming materials pass through a chemical casting form from which they can emerge only in the form of specific combinations for a given organism. How can this casting form be found?

Here we need to introduce two quite simple organizational concepts. The first of them is quite ordinary: a "regulator." This is a device which serves in order to maintain some process at a definite level. For example, machines often have a regulator of speed. If it is set, let us assume, at 1000 revolutions of the handwheel per minute, then with any excess of speed beyond this level it retards the movement; and when, on the contrary, the speed does not reach this magnitude, it acts in an accelerating fashion; less perfect regulators operate in one direction only, for example, with a steam boiler they do not permit the emergence of excessive steam which could explode it. It is clear, that a regulator is one of the varieties of the "casting forms" in our meaning of the word: with its help the "convergence" of various phases of a given process at a definite magnitude is called forth.

The second concept is a derivative of the first, but is more complex— a *bi-regular*, i.e., a "dual regulator." This is a combination in which two complexes *mutually* regulate each other. For example, it can be so arranged that the speed of motion and the pressure of steam in a steam engine mutually regulate each other: if the pressure rises above an appropriate level, then the speed also increases, and the mechanism which depends on speed then decreases the pressure, and conversely. Biregulators appear quite frequently in nature; for example, the familiar system of equilibrium "water-ice" under 0° centigrade. If water is being heated above zero, then the contiguous ice takes away surplus heat, absorbing it during melting; if there is a cooling off, then a part of the water freezes up, freeing the heat which does not permit the temperature of ice to drop below zero. In social organizations, a biregulator, in the form of the "mutual control" of individuals and institutions, etc., is quite widespread.

The bi-regulator is a system for which there is no need of an external regulator because the system regulates itself. And, evidently, if the living protoplasm turns out to be a chemical bi-regulator, then this will have explained why the materials entering it cannot change its composition, but confine themselves within its limits.

From the proteins of food are derived their structural elements, amino acids, which subsequently enter the tissues of the organism. The structure of these tissues is *colloidal:* a liquid with harder particles dispersed in it. This liquid is composed of water with salts, their "ions" and other crystalloidal substances, and also gases dissolved in it. The dispersed particles are molecules of proteins. Each of them is a bulky chemical complex, whose atomic weight is usually measured in the thousands, and appears as if a tiny island in this liquid.

With their very complex structure, protein molecules are quite fragile: both their decomposition and formation from amino acids occur quite easily with insignificant expenditures of energy, or with freeing of its insignificant quantity. Evidently, between them and their liquid environment there must exist a definite, structural correlation, guaranteeing their solidity— i.e., that these two parts form a *system of equilibrium*, in the way it is formed by water and ice under 0°. If such an equilibrium exists for the protein with a *given* content and structure, then for other proteins, generally speaking, this equilibrium should not exist in this environment, and finding themselves in it, their molecules are subjected to decomposition and regrouping of elements composing them.

Particles of amino acids of digested food enter into this environment. These particles are in a solution and, naturally, they enter into relationships among themselves. According to contemporary theoretical chemistry, with such an encounter of elements and groupings there must occur *all sorts of combinations*, only with varied speed of reaction, and moreover, with a varied stability of its results. Fragile combinations decompose immediately and are removed by negative selection; only firm and stable combinations are retained. And, as we already know, stable combinations in a *given* environment are only those which correspond to the composition of its protein molecules on hand. But this means that the entering amino acids are being "assimilated" and grouped into the same and not different proteins.

From this point of view it is clear why any protoplasm reproduces exactly its own proteins from any food; and it is clear how in a highly differentiated organism each of its most varied tissues reproduces its worn out protoplasmic elements and grows, remaining nevertheless the same in its composition.

But if this vital protein environment is the actual system of equilibrium in which the composition of proteins is regulated by the composition of the dispersed liquid, then it should be assumed that the composition of this liquid is also, in its turn, regulated by them, i.e., a bi-regulator is before us. Under conditions of great ease of decomposition and reunion, protein molecules, in fact, ought to be able to regulate the composition of the liquid; for example, they should be able to directly replenish them at the expense of their decomposition. The same amino acids may serve for bonding of any inorganic ions with their surplus, and for their release with their deficiency, etc.

On the other hand, it should be remembered that the contiguous tissues of the organism, undoubtedly form systems of equilibrium which are mutually regulated through diffusion of liquids and dissolved substances.

The dual structure of colloids generally contains conditions which are appropriate for a two-sided regulation. It is most probable that exactly this forms the basis of the indisoluble linkage between the vital processes and the colloidal structure of the substance.

Our construction is, of course, only a hypothesis; but it is easy to see that this hypothesis is a "working" hypothesis, i.e., it outlines the path of investigation, the path for its practical verification. Without preliminary constructions of this type, research cannot move forward and make headway because of the growing pile of facts. Subsequent investigation will either confirm or reject such a hypothesis, or cause it to be modified.

For tektology, however, any such construction represents a solution to the problem— *to organize harmoniously the given facts.* With an addition of new facts which cannot be confined within this solution, a special science will reject or alter it. But for tektology, in order to gather organizational experience and to work out organizational methods, this solution may even then have meaning, inasmuch as it facilitates the learning process of solving organizational problems in general. Thus, if our understanding of the mechanism of assimilation turns out to be incorrect or inadequate, its basic thought— the idea of a bi-regulator, its applications both in theoretical investigations, and also in practical constructions— would not lose its tektological suitability. And in the history of science there can be found quite a number of theories and hypotheses which became obsolete long ago, but which, nevertheless, can still serve as a valuable tektological material. In this sense, tektology will preserve and save for mankind much of its labour, crystallized in the verities of the past. Undoubtedly, contemporary verities will also become obsolete and die in their time; but tektology guarantees that even then they will not be simply discarded and will not be converted in the eyes of future generations into naked, fruitless illusions.

VI

Centralist and Skeletal Forms

The development of organizational forms through systemic divergence produces, among other things, two special cases, which are particularly important because of their prevalence and tektological role. They are "universal," not in the same sense as are ingression and disingression, which enter into determination of any organization in general, but in that they unfold on a universal scale and embrace all the fields of our experience. These two types play an exceptionally important role in organizational development: one of them *concentrates* activities and creates possibilities for their maximum accumulation within one system; the other predominantly *fixes* activities, secures them in a given form and conditions the maximum strength of a system. If the usual terms are used, but with a broader meaning, the first type could be called "centralist," the second, "skeletal." However, both these terms relate quite closely in our consciousness to definite social and biological forms, which, of course, are the most characteristic representations of these types, but which are far from expressing them fully on a universal scale. Therefore, we will introduce two new designations – "egression" and "degression" – which more closely correspond to the tektological idea.

1. The Origin and Development of Egression

Let there be an organized system, composed of several complexes A, B, C, D .... This may be the Sun with its planets and their satellites, a group of people, or a combination of concepts forming some classification, etc. The system changes, preserving its connections, and develops in this or that direction through an interaction with a favourable or unfavourable environment, i.e., under the conditions of both positive or negative selection. Its complexes change in mutual dependence, inasmuch as they remain parts of one whole. But the degree of this mutual dependence, the strength of the influence of one complex on another, may be different, and *uneven* at that: on the part, for example, of complex A, its influence on B is greater, than the reverse. Thus, the motion of this or that planet is determined by the Sun to a greater extent than the Sun's motion is determined by the planet; one member of the group "subordinates" to another, or imitates or follows this other member more often than that member follows him, etc. A relationship of this kind is called "egression," i.e., meaning literally from Latin, "going out of the ordinary." The complex which has a preponderating influence on other complexes, such as the Sun in the planetary system, the leader in a group of people, or a generalizing notion among more particular notions, is out of the ordinary; its distinction from others is an "egresive difference," and the complex itself, in relation to other complexes, is an "egresive center."

Systems of this kind are denoted in common parlance as "centralist." But since social groupings of this type are most familiar to us, we involuntarily represent other groups in a similar way, including even the same colouring of "authority-subordination" which is peculiar to the great majority of contemporary social egressions. The Sun is perceived to rule over planets, the brain over parts of the body, etc.; when people observe the life of bees, ants, or termites, and find in their organization an egressive center, the mother, they ascribe to her some kind of authority, which is reflected in the name, the "queen." All these are, of course, arbitrary and incorrect transfers by analogy.[1] Our concept of egression must be completely free of them, and fully express the objective, formal correlation of complexes. Let us consider the very origin of egression in several typical cases.

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In the contemporary organization of people there almost always exists an egression, if not in the form of "power," then in the form of factual *leadership*. There are, however, many reasons to believe that in primitive tribal groups such egression was absent — systematic guidance through a common effort did not exist: methods of struggle for survival were so simple and instinctive that each member knew as much as any other member. The germs of leadership — acts of imitation, a call to action — originated from different members of the group, not producing stable distinctions among them. The homogeneity of the group, however, was partial; there was an individual difference in "abilities," i.e., the psycho-physiological organization of human individuals; it was expressed in unequal initiative, speed and expediency of actions among the changing conditions of collective struggle with nature. That member of the commune who surpassed others in this, provided quite frequently an

[1]For example, the mother of social insects is only the center of generic life and the blood relation of the community, and not the leader of labour activities.

example or an instruction when needed, for example, at the approach of danger, or simply in cases of general indecision.

This primary difference *increased* with the passage of time; the man, who had a higher biological organization, mastered better and more fully than others the accumulating collective experience, and consequently differed increasingly more from them in the speed and success of orientation under conditions of everyday practice: a typical growth of tektological variety according to the law of divergence. This, on the whole, did not stop with the activity and death of such a man. Heredity transmitted to his children, in various degrees, his psychic flexibility and his organically-heightened type, especially since the most healthy and beautiful women, able to bear better children, usually fell to his share; and insofar as the father participated in the upbringing of children, they had an increased possibility of development in comparison with other children. Naturally, from among them, if not always, then in a great majority of cases, a person was singled out who was able to rise above the average level of his parents. In this way, the variety continued to grow little by little also in succeeding generations. Experience and the will of one person were becoming an increasingly more determining moment in the practice of the entire collective: a stable egression was developing.

In short, within the limits of one generation, a similar path of development is also repeated everywhere today. The emergence of leaders can be observed in friendly circles of children; but also any groupings of grown up people – professional, ideological, or political – arising on the basis of formal equality of all members, most frequently turn, consciously or unconsciously, into a type of egression.

In a continual chain of transition from embryos of egression to its higher levels, there is one moment which ought to be noted. If we denote the higher organized complex as A, and other complexes of the same system as K, L, M, N ...., then in their interaction the influence of A on K, or on L, is greater than the reverse influence of K or L on A; but all complexes *together* K, L, M, N ... may exert a more considerable determining influence on A than A exerts on them; in this instance, although the outstanding member of the group shows an example, or provides guiding instructions to each of the rest more frequently than each of them does to it, they nevertheless control it in the aggregate more than it does them. Such are the initial phases of the evolving egression in its partially expressed forms. When, however, egression reaches the level at which complexes K, L, M, N, ..., in the aggregate, are more determined in their changes by the complex A than it is determined by them, then we have a *fully expressed* egression. In our example, this corresponds to the phase when a permanent organiser – a patriarch or a leader who systematically directs tribal life – is singled out from the midst of a tribal commune.

In the above illustration one feature appears which has a general tektological significance. If a better organized complex A and the less organized parts of the same system K, L, M, N ... are in an environment which is identical to all of them, then the difference in their mutual influence, the "egressive difference," does not remain at one level, but *increases.* It is easy to understand why this is so, and why this is necessary; it is sufficient to take into account the relationship of the system, as a whole, and its separate parts to their environment.

The dynamic equilibrium of the system with its environment is always relative and approximate only; the environment is either favourable to it, and there is a preponderance of assimilation over losses of activities, i.e., positive selection accompanied by a growth in the sum of activities, or unfavourable, i.e., disassimilation preponderates and the selection is negative. Besides, a better organized complex has in both cases an advantage over the less well organized: it better assimilates the activities from the external environment and better counteracts its destructive influences. Consequently, under positive selection such a complex is enriched by activities faster than the complexes which are not as well organized, and is fortified at the expense of the environment; under negative selection it loses its activities more slowly than other complexes, and lags behind in the process of weakening. Evidently, in both cases the egressive difference between it and the remaining complexes increases.

It can also happen that complex A, with its superior organization, is "stronger" than its environment, taking from the environment more than the environment from it; then, since other complexes K, L, M ... are "weaker" than this same environment, the selection for A will be positive, and negative for K, L, M ... The egressive difference grows even faster under such conditions.

The egressive type of organization prevailed in social life during the entire historical epoch. The statement which has just been formulated is a necessary and sure guiding thread in the investigation of a great majority of cases of the evolution of such organizations. During revolutionary epochs, the process of conversion of organizations with an embryonic egression, in the form of a hardly noticeable authoritarianism, into organizations of fully expressed egression, strict authoritarian discipline and "firm rule," appears quite frequently and quite vividly.

We have established the inevitability of an increase in egressive difference among complexes of a system when they find themselves in an identical environment. But, of, course, the environment may also be different for them; this difference can also become a basis for the appearance and development of egression. Such, for example, is its origin in the solar-planetary system according to the Kantian-Laplacian theory. It is accepted that the mutual gravitation of elements of matter originally gave rise to an ordinary accumulation of "cosmic mists" – gigantic in volume complexes of extremely rarified substance and uneven density. But the middle and peripheral parts of similar complexes happened to find themselves under different conditions of the environment. Inasmuch as the accumulation of substance grew in general, attracting and joining the particles dispersed in the ether, it was under the influence of positive selection. This influence was strongest exactly for the parts in the middle; and not because they were better organized, but because they were already surrounded by the matter previously gathered at the periphery: there was a ready and rich material close at hand for their gathering activity and for their "force of attraction," i.e., the most favourable environment. On the contrary, peripheral parts had on one side the etheric environment, in which particles of matter were dispersed with an immeasurable rarity, and on the other, – the remaining mass of nebula, which continued to draw to itself the matter from the periphery. Not only was here much poorer material for assimilation, but there also appeared a clear tendency to draw in the substance which was already gathered and to rarify it for the benefit of the middle part; and this tendency intensified and became dominant sooner or later, causing the periphery to disappear under the operation of negative selection. Thus a central mass was formed – a better organized complex, because it contained a more significant sum of activities; the tektological difference between it and the periphy, evidently, increased. This was the original egression of the solar system; subsequently, only the forms of egression changed: the rings of mist were being isolated, revolving around the central mass, and with their disintegration there appeared planets, etc.

We will borrow from this illustration two terms for further analysis. The main, better organized complex of the egressive system will be called its "central" complex or simply the center; others, will be referred to as "peripheral" complexes; besides, we will bear in mind only the organizational relationships, removing completely from our consideration their spatial location. For example, in a system composed of a mother – a pregnant female – and her unborn young ones, the center of egression is, of course, the mother, and the young ones are "peripheral," i.e., structurally more dependent complexes, although in the locational sense the interrelation is quite the reverse.

This, moreover, is an example of still another origin of egression through division of the complex when from it separate its smaller or weaker organizational parts, while remaining in some systemic connection with it. Thus, from a central mass of the solar nebula planets were created; either all of them or, perhaps, only the "inner" planets which are closest to the Sun; the moon from the terrestial spheroid, etc.

The mother and her unborn young ones represent an appropriate illustration of the evolution of the egressive system in another way. The egressive difference does not increase here, but decreases, due to extremely different environmental conditions for different parts of the system. The embryonic cell is located in an ideal environment for development; but the organism of the mother must deal with severe conditions of external nature and its numerous elemental influences. Even if the predominant character of selection remains positive for the mother, i.e., even if her organism continues to grow, to accumulate energy, and to develop, positive selection can never be as intensive and fast as it is for the embryo, which is formed at the expense of her ready juices and under the protection of her tissues. Of course, the egressive difference decreases to a large extent from the moment of conception in the form of a single fertilized cell to the act of birth, when the child physically and physiologically separates from the mother.

The basic type of correlation does not change even after birth; it only receives another form and is not expressed so sharply. The mother or both parents together feed, guard and guide the infant; thus, they are chief in significance and, at the same time, maximally favourable complexes of the environment; they take upon themselves the greatest part of its hostile influences, and maintain the conditions which are beneficial for the infant. Therefore, the egressive difference continues to diminish; and finally, there comes a time when it is reduced to zero. The infant becomes a grown up man; the level of his vital organization is now not lower than that of his parents; in the family system, he is no more determined by them than they are determined by him. And the matter may not end there: parents "age" and become weaker under the influence of negative selection; the son becomes the head of the family: there occurs a "turning" point in egression, i.e., a change in the sign of its difference.

This illustration must be further elucidated, because our statement of the question at one point sharply contradicts the contemporary mode of thought. We consider the processes of growth of the organism, a halt in its development, and its subsequent downfall, on which depend changes in egressive difference, to be the result of correlations of the organism with its environment, which may be favourable or unfavourable to it. However, the traditional point of view is as follows: the organism grows in youth exactly because it is young, and because this is a natural course of the vital process; maturity leads to a halt in growth, and old age to a downfall because of the same natural cause; the surrounding environment is ignored here, because no favourable changes in the environment will ever force an old man to grow anew, as a child. This seems to be immutable, like all that is firmly crystallized in our experience.

But it is necessary to understand correctly and precisely what is meant by "environment." It is a totality of the external influences under which a system finds itself, but taken exactly in *relation* to it. Therefore, a different system will have a different environment. If an old organism is placed where a young organism is, then all the external influences will turn out to be different from what they are for the young organism. For example, the difference in body temperatures and the surrounding air will not be the same, because the temperature of blood drops in old age; the sum of light energy acting on the retina is not the same, because the transparency of the eyeball is lowered; all the irritations received by sense organs are not the same due to changes in the functions of these organs — the "blunting of sensitivity"; the action of oxygen in the lungs on blood is not what it was before, etc. And it is fully scientific to consider the senile downfall as a result of unfavourable external relationship for the organism or, which is the same thing, of the unfavourable environment; if the sum of activities of the organism is decreased, it means that the environment absorbes them and does not provide sufficient material for assimilation.

Of course, we are not yet successful in creating an environment, sufficiently favourable for the senile organism or, what reduces to the same thing, changing the organism so that such an environment could be created for it by our ordinary means. This is still an *unsolved* question; but there are no reasons to consider it *insoluble,* except for the conservatism of our thought. Even our medicine can partly solve it under definite conditions. And nature has solved it,in principle,for organizations which are higher and lower than our organism — for the unicellular creatures and for the collectives: their old age is not final; it can be replaced by a renewal.

As far as egression is concerned, its development may proceed in one or another direction, depending on the character of the environment in relation to the various parts of the system. In essence, the environment cannot ever be identical for the center and for the peripheral complexes: insofar as complexes differ structurally, they variously "receive," so to speak, its influences, with other things being equal. This must be constantly taken into account when investigating egressive forms.

The growth in egressive difference inside the primitive tribal groups led to the emergence of the permanent center in the person of a "patriarch": the director of work and distribution, the oldest and the most experienced member of the tribe. Until then, the living environment could be considered as being approximately identical for all the members of the group, with a correction only for differences among the organisms themselves — because both labour and distribution, being based on blood relations, remained quite uniform, and the external living situation was the same and common to all. But the permanent leader inevitably uses his position so as to depart from this uniformity; consciously or unconsciously, he gives some preferences to himself and, subsequently, to his closest relatives in the distribution of work and products. Then the egressive difference increases faster, and with it the heterogeneity of the living conditions within the commune develops even faster, etc. The inequality weakens the role of blood relations; subsequently, their boundaries break up completely and new forms of egression are created — feudalism and slavery with their progressive exploitation, which in the patriarchal-ancestral group existed only at the level of a hardly perceptible embryo.

There appears a picture of an unlimited, avalanche-like growth in the egressive difference on the basis of increasingly more favourable conditions for the central complex in comparison with the periphery. But with the closest investigation, this is not so simple. Any life in general, and the social life in particular, is a complicated system of various specific activities. The conditions which are quite favourable to the development of some of these activities may be completely unfavourable for others; this is exactly the case with the social egression which is connected with exploitation.

Two main groups of social activities are, on the one hand, those which are directed at production and, on the other, those which are related to consumption. With a developing exploitation, the environment of different parts of the system changes unevenly in relation to these two groups. As far as the exploiting persons, groups and classes are concerned, the higher is the exploitation, the wider are the possibilities of consumption for them; and in this sense, the egressive difference of the exploiting persons, groups and classes, evidently, does not cease to grow as long as the basic structure of the system is preserved. So, for example, in the case of feudal lords during the entire time of their supremacy, the growth in their needs and ability to utilize additional products in various subtle ways did not stop to the very end; the same is observed in the case of the bourgeoisie in the subsequent period. But a different situation prevailed as far as the productive activities were concerned. Only initially, with an insignificant vital separation of the ruling from the subordinated elements of social organization, the former can also progress in the productively-labouring direction, because they still remain in a direct, close contact with production: they partly work themselves, guiding subordinates by means of l i v i n g e x a m p l e, and partly intervene in their work, controlling and regulating its entire concrete progress, determining and experiencing it if not directly then indirectly. Later, rising more and more above the exploited, they departed further and further from the immediate labour process, limiting themselves to i n c r e a s i n g l y m o r e general direction and supervision; materials and instruments, i.e., the real conditions of production, cease to be their closest environment; all this is left up to their subordinates – peasants, serfs, slaves and workers; thus, exploiters gradually lose the basic preconditions for the development of productive activities; in this sense the environment becomes increasingly more unfavourable for them and, with the passage of time, there begins a regress or a downfall. Historically, usually in the end, there was a transformation of exploiters into parasites, i.e., a complete atrophy of their socio-labouring function and the loss of their entire sum of activities.

For the "peripheral complexes," i.e., in this case, the exploited dependent complexes, the environmental conditions appeared to be favourable in the sense of labour progress; that is, living interaction with the object of labour, physical nature, and with materials and instruments of production. But this is only one side of their "environment." Its other side is "central complexes," i.e., in our example, the exploiting elements. If these elements intensify exploitation more and more, and take away from the dependents an increasing amount of their vital energy in the form of products and in other ways (for example, cruel treatment), then all that is acquired by the working classes, on the one hand, is lost, and even with a surplus, on the other. The dependents find themselves under a continual operation of negative selection which accumulating, sooner or later reaches destructive proportions: they die off through exhaustion. So it was with the slave-owning ancient world: the master became feeble through idleness and luxury, and the slave weak from unbearable toil and severe conditions; as a result there was a general collapse of the system.

However, it is also possible to have a different result. At times the force of exploitation did not grow as fast as the labour development of the exploited classes; then the environment as a whole was favourable to them and their social energy increased in size. And this means that their resistance, in general, to any harmful influences also increased, including the resistence to intensification of exploitation, so that the latter could not grow with fatal speed. The degeneration of rulers into parasites went on side by side with the labour progress of the dependents, and the former egression was gradually undermined, but now into an entirely different direction. Another result is then also possible: a collapse, finally, not of the entire social organization, but only of its former "central complexes": the ruling groups or classes.

Various are the forms of egression and different are the paths of its evolution. But using the explained concepts and observing the relationships of the egressive system as a whole and its separate parts to their environment, it is possible, in principle, to establish a tendency of systemic development, and this means, to foresee, or even predetermine through systematic influence the subsequent fate of a system.

2. Significance and Limits of Egression

In the human organism there is its own central complex – the brain. All other organs, as the saying goes, are "subordinated" to it, and are determined by it in their reactions. This connection has a tremendous significance for the stability of the organism in its struggle for survival and in its development: thanks to the dependence on our center, activities – resistances of the whole can be concentrated at various points and in various directions in its interaction with the external environment. The fate of a system, as we know, is determined by its least relative resistances to the hostile influence of the environment; the activity of the brain permits the organism to raise these minima where there is a threat, or where it is necessary to do so in general: the activities are transferred there from other parts of the system in a coordinated fashion. The eye, for example, is quite defenseless by itself even in relation to small mechanical forces; but when such forces are directed against it, then in a great majority of cases they run up against the relatively greater resistance of the fore-parts, or even do not reach the organism because of the activities of other organs changing the position of the body. Or, for example, the concentration of the action of hands, feet and teeth on one object— an enemy— will remove possible harm incomparably more expediently and faster then the efforts of any one of these organs alone.

The significance of the egressive connection appears even more vividly in the system of a *chain egression,* such as, for example, the army. A series of complexes of a lower order— commanders of small detachments – are united by the center of a higher order, such as the head of a larger detachment; a series of such centers to still higher ones, etc.,: platoon officers, company and regiment commanders, and generals right up to the commander-in-chief. A million strong living force is bound together through these interval links, and the chief center determines its mass movements, directing hundreds of thousands of human beings into places where there is the least relative resistance, or where the greatest relative action is necessary.

Each complex represents something limited, and because of this can be directly connected with a limited number of complexes analogous to it; for example, man is able to maintain a living and harmonious *direct* collaboration on a more or less complex job with no more than several tens of men; with other forms of labour even fewer than that. But if one person is able to direct, let us say, even ten persons only, then with a two-level egression the higher leader, having to deal with ten lower ones, can direct a hundred men; and with a three-level egression, one thousand, etc.; the chain egression of six links will then unite a million, and of nine links a billion men.

Thus egression concentrates activities. It may appear that with a chain egression this concentration has no limits. In reality, however, they always exist. And this is not simply a fact, known from observation: tektological investigation shows that it flows from organizational necessity and that egression is limited in its nature.

The point is that the chain of egression cannot unfold link by link, without end. Between any higher link and a lower link directly connected with it there must always exist an egressive difference denoting a different level of organization; the transition from the higher link to lower links corresponds to a *reduction in the level of organization,* which must be sufficiently large for the lower links to be continually and firmly determined in their changes by the higher link. Consequently, for an infinite series of links, it would be necessary to have an infinite number of such reductions; the question then concerns a possibility of this happening.

It is easy to conceive such series in the abstract; for example, take a mathematical descending progression:

l; 0.1 ; 0.01 ; 0.001 ; 0.0001 ; 0.00001 ; etc.

But can a similar correlation be realized in the form of a real egression? Any organizational connection, including, of course, the egressive connection, relates to *definite* activities; for example, the connection of an army of officials or an industrial hierarchy relates to "organizational" activities; the connection of the solar system, planets and their satellites relates to the activities of "attraction," etc. For an infinite series of links with their egressive differences, it would be necessary to divide these activities infinitely. But in our experience none of the real activities can be divided without end and remain at the same time unchanged. That organizational activities cannot be divided without limit is clear in itself; but the same should be said about the activities of gravitation: they can be divided up to the "material atom"; and if we go further, then other electrical activities would be now before us; vital activities can be considered as such up to the particle of the living protein, and with further division we can talk only about chemical and physical activities of the "dead" substance, etc. It means that in any egressive chain, coming down from link to link, we inevitably reach the one where, with a further reduction of the level of organization, other activities begin, and not those which characterize our egression. It is not excluded, of course, that these other activities, in turn, create a chain egression, but this will not be the previous one, but a new chain, another system, with its special correlations.

Practically, this limitation is also expressed in that with the lengthening of the egressive chain, its lower links are less and less determined by the central complex. So, in a despotic monarchy, a sultan, a king or a shah actually directs his ministers; they, their closest officials, etc., down to the last peasant; but the connection of this peasant to the monarch is quite negligible because of its distance; it is so indirect that it represents only a weak hint as to the real leadership. Such a connection may be sufficient under a stable equilibrium of the entire system; but its weakness is revealed when there appear processes of development or disintegration. Then, for example, it turns out that the most commanding despot is unable to achieve any obedience from the masses, or that the most benevolent ruler is not in a position to do anything for them. So, too, a general separated from soldiers by the whole series of interval steps can have very little influence on those changes of their "spirit" which swiftly unfold during the battle and determine its outcome. This weakening chain of connections puts a limit to the concentrating strength of any given egression.

Another moment operates in the same direction— the accumulation of systemic contradictions. Egression is a special case of differentiation or organizational divergence; the broader is the egression and the further it unfolds, the stronger becomes this differentiation with all its consequences; and one of them, quite inescapable, as we know, is the development of systemic contradictions. And even here especially vivid, graphic examples are encountered.

Such are the already mentioned "authoritarian" organizations, so far the most widespread type of egression in society. Their forms have been quite varied in the history of mankind: patriarchal commune, feudal formation, slave-owning economy, the eastern despotism, bureaucracy, modern army, and petty bourgeois family, etc. If their evolution is observed over a sufficient period of time, then there emerges a picture which is the same in its general features. Partial contradictions are discovered almost from the very beginning. A psychological divergence develops between the central complex and peripheral complexes, between the "organizers" or rulers and the "executants" or subordinates, hampering their mutual understanding; and then a tendency to lessen this understanding intensifies more and more. Hence, there occur increasingly more frequent "errors" and unconscious, disorganizing acts on both sides. For example, an officer who is unable to penetrate into the emotional state of his soldiers, gives inexpedient and also factually unrealizable orders; the soldier, having been used to obey only blindly, falls into confusion with a change in the situation, which is not anticipated in the orders, though this change may be quite insignificant; a slave-owner or a despot, not heeding the feelings of the people subordinated to them, exhibits "whims" and "arbitrariness;" from this secret or open reactions of bitterness follow; all these are origins of a fruitless waste of energy lowering the viability of organizations.

The intensification of similar contradictions usually led to the disintegration and collapse of authoritarian groupings. Thus, the ancient world perished from the results of excessive differentiation of the two of its poles. The slave-owners and bureaucracy of the Roman Empire turned into pure parasites, only able to consume on a tremendous scale socio-labouring activities embodied in the products of labour of other classes, but not able to retain the organizational energy and ability necessary for the direction of labour processes and the struggle with the hostile environment which surrounded the Empire; slaves, on the other hand, degenerated and died off from the excessiveness of toil and insufficiency of consumption; but, at that time, they could not fight against the overpowering exploitation, and did not even dream of reconstruction of the social life by their own efforts because of their slave mentality; the remaining classes also fluctuated between parasitism and exhaustion, or combined both, as did the urban "proletariat" of those days, living in misery and idleness on paltry doles of the rich and the sale of their votes and services to political groups. The "spiritual linkage" lessened and weakened in the entire society, i.e., a community of interest and mutual understanding; and the coordination of forces and practical organization depend on this linkage. It grew weaker, i.e., there occurred internal disorganization; the productive energy of the society dropped; and the society had to perish under the blows of the very same barbaric tribes which it had previously easily conquered and exploited as the source of slaves.

In a similar way an army, in which the isolation of soldiers from officers reaches such extremes that there is no vital intercourse and solidarity between them, becomes helpless in any moderately serious struggle. The subordinates receive orders of superiors without understanding and trust; superiors are not able to take into account the abilities and, especially, the sentiments of their subordinates; as a result, there occur irreparable errors of leadership, sluggishness and unreliability of execution, which lead to the inevitable catastrophe.

Also, an authoritarian family of petty bourgeois, peasants, merchants or landowners often disintegrates as a consequence of the development of the despotism of its head. Not taking into account the personal life of his wife and children, not even perceiving it to any extent, he deals inexpediently with them, running against unexpected resistances, passes from misunderstanding to animosity, which, of course, becomes mutual, and, finally, with his own hands destroys the family ties, the basis of his power. Pictures of such disintegration of patriarchally-organized family are one of the favourite plots of the old novelists.

In a separate organism, the brain is an egressive center. The environment is more favourable for the brain than it is for other organs: the brain is protected from the external environment, and the internal nutritious environment — the blood and lymph — is unevenly distributed in its favour. Naturally, the egressive difference grows: in the development of the organism the relative significance of the brain and its "power" over the whole increase; and this process is not interrupted even when life begins to decline. The sum of accumulated activities of the brain, expressed in the richness of experience and elaboration of methods, reaches a maximum when other organs and the entire periphery are already weakened. Then there is revealed a systemic contradiction, because the executing activities of other organs are inadequate for the organizational strength of the brain, and a part of them is fruitlessly lost. *Si jeunesse savait s'veillsse pouvait*! — "if only youth knew, if only old age could!" — so popular wisdom noted the bitterness of this contradiction.

The solar and similar systems are examples of egression in the inorganic world. Their contradictions can be captured with contemporary methods only theoretically. If, as this may be assumed with the greatest foundation, the Sun, together with its planets, continues to gather matter dispersed in the surrounding space, then after a sufficient passage of time it, due to the augmentation of its mass, will inevitably attract and swallow these planets. And if contemporary ideas concerning the structure of atoms are correct, then the fall of large planets into the Sun must lead to a significant disintegration of matter itself.

The method of settling contradictions of egression is, in principle, the same as that for other forms of divergence, namely – contra-differentiation. This is what is observed, for example, in some social groupings of this type, and is usually called as their "democratization": the governed take part in the direction of common affairs; the rulers, formerly in their commanding grandeur torn away from the living executing practice, are forced into a closer intercourse with it; and systemic couplings are strengthened in this way. The newest revolutions, in general, follow the lines of a similar contra-differentiation: the "bourgeois" tended to a merging, i.e., conjunction of estates, the ruling with the lower classes; the "socialists" will have to face the problem of the amalgamation of classes. The circumstance that conjunction here follows the forms of struggle or even war, as we already pointed out, does not change the substance of the tektological fact.

In egressive systems there are still other special contradictions which depend not so much on differentiation as on its incompleteness; they are observed in cases of so-called "multi-centers." Harmoniously organized egression is characterized by a *single* center; and if it is of a complex, chain type, then it has one higher, common center, and each group of its members is directly connected with the one closest to it center and not with two or several centers. But, in reality, such a correct form of connection is far from being always observed: systems are encountered with two or more chief centers, with the parallelism of connections of some lower centers, in short – not corresponding to the principle of a ***"single center."*** Inasmuch as this is so, imbalance, contradictions and disorganization are exhibited in such systems. The determining influence of one center on its periphery runs against the determining influence of another, and unstable correlations result therefrom. Ancient wisdom expresses this by a dictum on the theme that: "one servant cannot serve two masters." And actually, the contradiction appears especially vividly in authoritarian form of egression; and the ancients did not know other forms; but the rule remains everywhere the same.

In our planetary system there is a single center – the Sun; the satellites are also connected with their planets by means of multi-centers; and the whole, according to our ideas, is quite well balanced. Among double stars, however, the real "twins" are apparently also encountered: pairs of approximately equal in mass suns, which rotate around their common center of gravity. We, of course, do not yet know, if these suns have planets; but the existence of planets is not improbable. It can only be said with assurance that in quite a wide belt *between* the suns, exactly where their attractions compete to a significant degree, planets should not exist: calculations show that stable orbits should not be expected there. If, however, common planets are possible, then only at such a great distance from both suns where their action blends to a sufficient degree so that together they form a single center for those planets or, more correctly, where this role is performed by their common center of gravity.

There exist, as it can be assumed according to some facts, star systems where a bright satellite rotates around a black central body, giving radiant energy both to this black body and to all other planets: one center exists for the activities of attraction, another for the activities of "light and heat." Is this a double-center? No, these are simply two different egressive organizations, relating to different activities, each with a single center; both "suns," the black and the bright, do not compete with each other in their *different* centralist functions. Similarly, if the Earth ever becomes the center of life for all the planets of our system — will populate them with its emigrants — this will not create any organizational contradiction with the central role of the Sun.

However, the question of double-centers is not always solved so simply. For example, in feudal organizations of various countries and epochs there was the power of priests, on the one hand, and the power of secular feudal lords, on the other. In some cases, the parallel existence of both powers continued for centuries without a perceptible disorganization of the social whole; in others, on the contrary, there were outbreaks of cruel struggle between them, which, through an enormous waste of effort, led to subjugation of this or that side, i.e., generally to a single center. Why such differences?

The priest and the secular feudal lord are defined according to their original economic significance as the "peacefully-productive" and the "military" organizers in a commune or society: in the hands of one, the highest direction of peacefully-labouring practice of the collective was concentrated, in the hands of another — the same direction of the military practice, so important under feudalism with its innumerable petty and large-scale wars. Each, consequently, had his special field of gathering and concentration of social activities; and inasmuch as this was so, we have here not one but two different egressions; double-centers under these conditions do not occur, and a stable organization is possible.

But the linkage in social life is so close, its elements are so intertwined, that discrimination between the two fields of activities is never complete: they partly intermingle, and the central functions to some degree merge on this or that side. Thus, the upbringing of the youth is generally in the hands of priests; however, a military leader also cannot help but interfere in this matter: he has to look after the preparation of cadres for his troops; and his independent calculations may frequently be at variance with those of the priest — even in questions of allocation of time of the learning youth. Sometimes, the fighting instincts of warriors are revealed in the oppression of the more peaceful members of their own commune, and the restoration of order then concerns both leaders, but their tendencies may turn out to be in a practical contradiction: each defends his "own." Generally, the sum of vital activities of a given organization is limited and, therefore, their concentration around one authority often occurs at the expense of forces connected with another authority; for example, the most intelligent students of the priest, whom he contemplates to have as successors, are enticed from him into the army, and this leads to conflicts and struggle.

When, however, feudal exploitation develops widely, then contradictions and the struggle of the two powers become a constant phenomenon. The entire "additional energy" of society, i.e., the entire surplus of activities assimilated by society from nature over its labour expenditures serves as the field of exploitation; this is one and the same sum of the real things – "the surplus product" – on which both ruling estates draw; the more one takes the less remains for the other. This is quite a definite double-centrism; it develops into a chronic, growing disorganization, into a sharp struggle, right up to an annihilating civil war; such was the case during the latter part of the feudal epoch in many countries – Europe, East-Indies, Palestine, Japan, etc. The only solution is a real single-centrism; that is, the transfer of supremacy to one side and subordination of the other; the fuller and the more consistent it is, the more perfect and reliable is the cessation of disorganization.

It should be remembered that internal contradictions, though significant, will not impede the existence of the system and even its program, if only the level of its organization outweighs these contradictions. Therefore, there are numerous double-centered and multi-centered egressions which are preserved and developed. There are many of them, especially, in the realm of life, both elemental and social life.

A vivid example of the most complex multi-centers is the economy of the old capitalist society. Each of its component complexes – enterprises, has its special center in the person of the boss, owner, individual or a collective. Specific activities, organized in various enterprises, are in part different, and in part, however, the same. They are different inasmuch as there is a social division of labour and individual forms of productive activity directed at production of these or those special products; they are the same inasmuch as in each such branch there is not one, but several or a multitude of competing enterprises which are bound together by the market into one common field of exploitation, where all the types of labour activities have an identical form of values. Hence a continual economic struggle arises, characterising capitalism, and with it a corresponding waste of social energies: that chronic, at times aggravating, illness which was ascertained by the bourgeois science. Notwithstanding, the capitalist society was not only preserved, but also developed fast, because the total sum of its level of organization far surpassed the disorganizing moments. However, this correlation cannot be maintained indefinitely: sooner or later, systemic contradictions become so intense that they surpass the organizational linkage; then a crisis must ensue, leading either to its transformation, or to disintegration, a collapse.

Capitalism has already suffered such crises a number of times, and emerged from them partly transformed by entering into increasingly newer phases of its development. But the multi-centers remained, though a number of centers decreased; and again the disorganizing forces grew right up to a new crisis. It turned out that with a fewer number of centers, economic contradictions can develop no less sharply, and generally speaking, even more sharply. In the initial phases of industrial capitalism, when there was a great number of small and average enterprises, disasters of competition were much weaker, and general crises of production were not observed; when large enterprises became predominant, competition intensified and general crises appeared; when tens and hundreds of enterprises began to unite into syndicates or amalgamate into trusts, the struggle became even more cruel, and the waste of energies on it even more significant; when, however, groupings of financial capital, binding thousands upon thousands of enterprises, embraced the entire capitalist world, the whole matter came to an unprecendented deep crisis – the World War, with its collossal disorganization of human energies.

This appears at first sight to be a kind of tektological paradox: if a deviation from the single center brings about disorganization, then, it would seem, the greater the number of centers, the greater disorganization, and the closer their union, the smaller their disorganization. But the paradox can be explained in a straightforward way if the significance of egression is taken into account. Egression *concentrates* activities. If the number of centers decreases, and the system itself is preserved in former dimensions or grows – as is the case under capitalism – then, this means that the activities – here especially socio-economic – are concentrated in it with a greater force; they become relatively more intensive. And disorganization depends here on the fact that with the independence of separate centers the activities organized by them are not coordinated, but can come into conflict with each other. It is clear that conflicts of more concentrated activities, i.e., more significant and intensive activities, are able to bring about a sharper and deeper disorganization. Tektologically, it is quite similar to the clash of huge boulders in their elemental motion, instead of the multitude of tiny bodies, from which they originated.

It is easy to illustrate once more the significance of organizational science on the principle of a single center. In the history of Russian social-democracy there is an example of a naive violation of this principle which led to considerable harmful consequences. At the Congress of 1903, the direction of the party was entrusted at first to two centers, the editorial board of the central organ and the central committee. Of course, this was done for various political considerations arising from the grouping of forces at the congress; but the important thing is that no consideration was given beforehand to the organizational outcomes of this decision. If the question was stated thus, then it would have been easy to ascertain that these were two inescapably competing establishments, since their field of activities, as outlined in general and as a whole, was identical: its essence was contained in political direction of the party. There was a vague, instinctive feeling that the roles should be divided so that one center would organize one set of activities, and the other – another: "literary" and "practical"; but the most moderate organizatonal analysis would have shown that literary activities only serve for the organization of the same practical activities and cannot constitute a special system; and the historical experience of feudalism with its struggle of the "spiritual" and "secular" centers should have been a sufficient warning. The double-centrism had severely aggravated the internal strife between the two hardly outlined trends within the party and caused a great waste of energies, which were needed for the external struggle – and this helped to create a split in the party. In view of this severe experience, double-centrism was unanimously rejected after two years; but the same could have been done from the very beginning with great benefits to the cause, if the party were built according to scientifically-organizational principles, on the basis of past tektological experience of mankind, and not gropingly, through instinctive attempts and rejection of forms which turned out to be in fact unfortunate and only succeeded in bringing harm.

Similar errors, on the part of individuals and entire collectives, are always possible and will be repeated for as long as the organizational consciousness of people is not shaped into a precise and strict science.

We have mentioned the *universal scale* of egression. At the same time we have explained the inevitable *limit* to any given egression. There is no contradiction here if we take into account the fact that though the scale relating to *our* universe, to the field of labour and experience of mankind, is continually unfolding, it remains nevertheless limited at any given time. The universal egression is the connection of mankind and external nature. The human collective, in all its practice and cognition, appears as the organizing center for the rest of nature: it "subordinates" nature and "rules" over nature to the extent of its energies and experience. These expressions are metaphors which are taken from social life and from authoritarian forms; but here the real linkage is expressed– the universal egression, whose boundaries are continually broadened, is *forged* by labour and thought.

Mankind is in a "struggle" with nature; this is also a metaphor expressing a disorganizing correlation; inasmuch as disorganization exists, egression, of course, is absent, because there is not a single system. But inasmuch as the labour collective "conquers" nature, gains mastery over the various activities of nature and concentrates them as its *own* activities, it becomes the central, determining complex for the "conquered" complexes of nature: a single egressive system is formed here, and besides, what is especially important, this system is characterized by a chain egression.

Other animals, in their struggle for survival, also master various activities and resistances of the surrounding environment: they build dwellings, and gather supplies, etc. But animals cannot succeed in what man has succeeded, and what constitutes his basic distinction from the animal world: to make this egression a chain egression – having mastered certain complexes of external activities, to rule *with their aid* over others. Therein lies the objective significance of the utilization of *instruments*. The animal organizes elements of the environment only by means of the organs of its body; man with an aid of his organs controls instruments, and by means of instruments controls other external objects: in egression there was added still another link. The result is a tremendous broadening and departure from the constraints which are posited for animals by the limitation of their organs.

In this respect,mankind had experienced one grandiose revolution; that is, the transition from manual to machine production. In manual labour, organs of the human body control the instruments directly; thus, the number of instruments in action cannot exceed definite limits, on which then also depend the limits of human "mastery over nature." In machine production a new link of egression – a mechanism – is introduced between the hand of man and the working tool. Thus, a new broadening of egression is also achieved, and quite a significant one at that: the mechanism is free from the biological limitation of organs of the body and can control at the same time an indefinitely large number of instruments. Subsequently, the egression developed in a form of a chain of mechanisms, where some of them put into motion or regulated others. In this way machine technology creates conditions for an indefinitely growing concentration of the activities of nature in the service of mankind – for an organization of the world under its control.

3. The Origin and Significance of Degression

In the preceding discussion we have often encountered the notion of organizational *plasticity.* It denotes a mobile, flexible character of couplings of the complex, and ease in regrouping of its elements. It has a tremendous significance for organizational development. The more plastic is the complex, the greater is the number of combinations that can be formed under any conditions which change it, the richer is the material of selection, and the faster and more fully is its adaptation to these conditions. For example, the concentration of activities at those points where it is required according to the law of the minimum, i.e., where, let us assume, external influences threaten the destruction of a part of the complex, is possible only with an appropriate plasticity. If life conquers dead nature, if the fragile human brain has mastery over fire and steel, it is precisely because of its plasticity. Plasticity of the living protoplasm is the basis of the entire biological and social evolution.

Tektological progress, based on plasticity, leads to *complexity* of organizational forms, since adaptations to newer and newer changing conditions are accumulated in them. In its turn, complexity is favourable to the development of plasticity, since it enlarges the richness of possible combinations. Therefore, in general, the higher is the level of organization, the more complex and plastic it is.

But there is also another aspect: parallel with these positive features there grows one, also quite important, negative property: "tenderness" or "vulnerability" of organization. The mobility of elements permits also a relatively easy destruction of connections among them; and the complexity of internal equilibria of a system also means their relative instability. A vivid illustration of this is the human brain. This is the most highly organized of all biological complexes, the most intricate, the most plastic, but also the most tender complex; it can be disorganized by the most insignificant harmful influences once they gain access to it.

One of the most typical tektological contradictions is here before us: the growth of organization in certain directions is achieved at the expense of its reduction in others. From this contradiction a problem springs up which must be resolved by organizational development; the problem of course, in the *objective* meaning of the word, denoting precisely the necessary line of development. Let us elucidate this more concretely.

Let there be a living free cell in the water environment, one of the simplest organisms, a microscopic being of protoplasm in a dynamic equilibrium with its environment. The equilibrium reduces to an exchange of substances and energy. The cell assimilates some materials from outside and discharges others. The latter are generally denoted as "skeletal" products; they are the result of decomposition of tissues of the cell itself and the waste matter from processing the elements of the environment captured by it. Some of these skeletal products are directly harmful to the cell; they are "toxic," they destroy it if they accumulate in it or come in contact with it; others are more or less neutral; all of them, in general, are characterized, of course, by a *lower* level of organization in comparison with the protoplasm. The products which are more neutral may temporarily accumulate around the cell, or even inside it, without a special damage to it. With their lower level of organization, some of them may turn out to be considerably more *durable* in relation to many influences which are destructive to the cell. If these influences, being diverted against the skeletal products, are thereby paralyzed and do not reach the cell, then for the cell this is a straight vital advantage, and the processes of selection will continue in this direction in order to maintain, to a certain extent, connections between the cell and such skeletal products. For example, if lime salts are dissolved in the water environment, then the cell, discharging carbon dioxide during its breathing, inevitably deposits inside and around itself carbonic lime; this lime is able to serve as a protection for the cell, forming an external skeleton, or to enlarge the mechanical stability of its form when deposited inside. Lime skeletons of many rhizopods were formed in this way, for example, those, which are composed of chalk layers – and also skeletons of some polips and many molluscs. In other cases, a similar role is performed by other discharged substances: cellular tissue forming the external membrane of most plant cells, silica with some simplest cells, chitins in the case of crawfish, spiders, and insects, etc.

Man possesses an external skeleton of a corneous tissue of epidermis and bones lying under it – the spine and others. The first protects the body from most of the harmful physical and chemical influences, the second gives it a general mechanical stability. But it should not be thought that these are fundamentally different organizational adaptations: their role is in essence homogeneous. If the body is influenced, for example, by mechanical forces aiming to break or deform it, then these forces encounter a resistance at first in the skin with its epidermis; when, however, this turns out to be inadequate, then due to the resilience of the skin and softness of tissues under it, these forces, while not yet breaking connections of the tissues and only deforming them, are passed on to the internal, osseous skeleton, whose firmness usually paralyzes them, continuing the function of the external, skin skeleton. In different animals this or that skeleton serves as a substitute for the other; for example, in the case of insects the chitinous membrane and of most molluscs the shell make the internal skeleton superfluous; but in the case of cuttlefish, the so-called "bone" is its skeleton, which is composed of carbonic lime, and not from phosphoric-acid lime, as is the case with our bones; in essence, this is an internal shell instead of an external one; it provides stability to the soft body of the mollusc against the influences which deform or break it.

It should be noted that we now use the words "internal" and "external" in their usual, spatial sense; but for tektology, the science about organizational relationships, their meaning must inevitably be a different one. The microbes of various illnesses are spatially located inside the body, but tektologically they are an *external* force to it, for they do not belong to its organization; this is another organizational form alien to the body and contending with it. On the other hand, if several workers work at one machine, then as far as their system of collaboration is concerned, their relation to this machine, which binds them together, is an *internal* connection of the system, although this is a relation to a spatially-external object. And from this point of view the spatially-internal skeleton is, of course, a protection against external disorganizing influences.

Further, there are no bases for contrasting tektologically the protective and offensive functions of the skeletal parts. For example, the role of claws and teeth appears to be quite different from the role of other corneous and skeletal elements. But for organizational science all activities and resistances are correlative, so that the difference between the protection of plastic parts of the system from activities against which they are not able to resist on their own, and the overcoming by them of resistances which they cannot overcome directly reduces to the choice of a point of view, so to speak, or the position of the investigator.

Skeletal complexes should not necessarily be perceived as being firmer or harder in a mechanical sense. When a pursued cuttlefish surrounds itslef with a cloud of ink-liquid, making the water opaque so that the efforts of an enemy cannot be precisely directed and fail to achieve their objective, this is also a temporary external skeleton of the cuttlefish, opposing only a special group of destructive environmental forces, the energy of animals which are guided by sight. In the case of some animals, the zone surrounding them of specific smell, repulsive to other animals is the same kind of an "external skeleton"; even the colouring of some harmless insects, imitating the colouring of other poisonous ones, and thus deflecting an attack of many predators, etc., is such a skeleton.

Such is the typical origin of "skeletal" forms in the realm of life: they arise at the expense of the organizationally lower groupings, which are discharged, or "disassimilated" by plastic complexes. However, they are much more widespread than this –– plasticity and firmness are peculiar, in various degrees, to all the levels of organization. Therefore, we shall replace the customary, but quite narrow designation of the "skeletal form" by a new term – "degression," which means in Latin – "descent down," without imparting to it, of course, such a negative meaning as is imparted to such related words as "degradation" (decline), or "regress" (backward movement). On the contrary, degression is an organizational form of a tremendous *positive* significance: only degression makes a higher development of plastic forms possible, fixing, securing their activities, and protecting tender combinations from their rough environment.

Hence, we have a gigantic breadth of application of degression in the technical life of society. Here belong clothing – an additional external skeleton of the body – and a dwelling, an analogous skeleton of a higher order; cases and boxes for the preservation of all kinds of products of labour, and vessels for liquids, etc. Here, naturally, the material for degression may be of other than "skeletal" origin, not from waste matter of the vital exchange with the environment, but generally any material which is suitable for the technical problem in question. This relates not only to human technology, but equally well to its embryos in the animal kingdom. Fistular worms, certain larvae and other animals make protective casings for themselves out of whatever hard particles can be found – grains of sand, tiny shells and bits of wood, etc., and they usually do this by sticking them together with special secretions. Nests of birds, hives of bees and wasps, and other similar structures – collective external skeletons – are built mainly out of suitable elements of the external environment; although here the discharged skeletal substances in the form of cement are also sometimes intermixed.

As far as inorganic nature is concerned, we can consider the hard bed of a lake or river channel as a natural vessel for water, protecting the form of the plastic liquid complex; and when a part of water freezes on the surface, the ice complements this degression. Even the surface layer of liquids, in general, with its special mechanical properties making it a sort of stretched resilient membrane, performs analogous functions; for an individual drop of water it forms a kind of an invisible vessel, determining and to a certain extent protecting its form.

Symbols of various kinds, in particular the most typical and widespread of them – the word, represent an extraordinarily important and interesting case of degression. The word is a peculiar center uniting a whole series of notions, their entire "association"; for example, the word "man" binds together for our psychics thousands, perhaps, millions of notions about people existing now, in the past or in the future, taken from the most different stages of their development and under the most different conditions. This is a center, but not an egressive one; the uniting role of the word is not based on its higher level of organization, but on its greater stability and firmness. Notions, mental images and memories of derivative complexes, grouping in masses, at times quite countless, in association "according to likeness," influencing each other and inter-mingling, have a tendency to disintegrate in the psychic environment. Again and again rising from among others, they are reproduced partially each time and with variations; their chains intertwine; their accumulation would have finally produced as a result a completely confused, chaotic tissue, if they were not bound and retained in separate groups by stable, firm complexes: words, and also other symbols, such as, for example, scientific signs and schemes, and works of art, etc.

The symbol is a complex which is generally not more highly organized than any of the notions united by it; it is enough to compare even the same word "man" with a concrete psychic image of man. And it would be incorrect to say that the word "determines" changes of the notions connected with it; this also does not happen because the word is incomparably less changeable and less plastic then they are; and such are also other symbols. The point is exactly in this stability: symbols *fix,* i.e., fasten, hold and protect from decay the living plastic tissue of mental images, completely analogously to how the skeleton fixes the living, plastic tissue of the colloidal proteins of our body.

Usually it is said of symbols that they "convey" their content. The term "to convey" refers to a definite social connection: the connection of mutual understanding, i.e., psychic intercourse and transfer of all kinds of experiences among members of the social whole; with the aid of symbols, especially words, people communicate them to each other. And indeed, the origin of symbols is social: it is exactly the social need in securing and fixing of the labour experience that became the initial point of their development. It is quite natural and clear that only the fixed material of experience can be communicated from one man to another and stored within a collective; and, on the other hand, only the social retention and collective storage of experience and of its forms brings this material into the field of science, any science in general,and tektology in particular: purely individual retention and storage would have had an inevitable end with the death of the organism.

It is interesting to note that the basic groups of these forms of degression, the words, also originated from peculiar "wastes" of human evolution. According to a brilliant theory of Ludwig Noire, "the original roots" of speech were labour interjections and involuntary shouts accompanying a collective action: these shouts were by themselves understandable to all through the designation of corresponding labour acts. So, for example, we also, not seeing workers behind the wall, but hearing the sound "ooh," escaping from them would have guessed that they pulled something with effort; or, on board ship, from the sound "hop-la," we would understand that sailors are lifting something heavy; this comprehension was the initial point of development of such sounds into words and into elements of speech. But such interjections are brought about, in essence, by "superfluous" and "unnecessary" muscular contractions: besides the muscles which work strictly for a practical aim, other muscles also contract – the vocal cords, throat muscles, tongue, and lips, etc., and as a consequence the air expired from the chest produces quite a definite sound vibration which is apprehended by all who surround it. Physiology explains that such "superfluous" contractions occur with any moderately significant effort: they are the result of the "irradiation" of nervous excitation in the motor centers of the brain, i.e., this excitation, being not limited by the basic working centers, spreads from them through associative side-paths to other sufficiently close parts. Irradiation affects now these and now those muscles: with lifting of a great weight, the face becomes distorted and the feet tremble; with writing, children unaccustomed to it put out their tongues; with a gymnastic mode of lifting oneself up by hands, the feet twitch, etc.; sound reflexes are only a particular case. All are, of course, an unnecessary waste of activities of the organism, and, in general, the evolutionary process rejects them, or, more correctly, reduces them to a minimum: so-called purity or distinctness of movements in gymnastics or work reduces to the contraction of only those muscles which are strictly necessary for the performance of the task; reflexes of irradiation are rejected as the skeletal elements are also rejected. But, as we see, in the social evolution of people a part of these reflexes, namely the sound, is used for the retention of experience of labour processes, i.e., the experience of motor efforts, which is the basis of any experience in general. Let us take the Aryan root "ku" or "sku." from which in Russian, Latin, German and other related languages a multitude of words originated with the meaning "to dig" and various words similar to it. Its origin was, probably, a sound escaping from the worker as a result of pressure of the chest against some primitive instrument which was used for digging, a prototype of the spade. Already then many of the various labour reactions were fixed by this one "word." The execution of the act of digging by each worker was evidently changing as it was perfected; and with various people it was generally even more different. But later the same word denoted all that was able to call forth in man a living, "impelling notion" about the act of digging: not only its performance by the mentioned instrument, but any digging, even by hands, consisting of completely different movements; subsequently, scraping of a cavity in a piece of wood or stone (the word "to scrape" is of the same root not in vain); later, the analogous work not of man, but of a mole or a shrew; later, the instrument of digging itself; the dug up earth; and the cave, though of a natural origin, etc. To the childish impulsiveness of the savage, any such perceptions or even a living image of anything similar was sufficient in order to provoke in his brain an involuntary impulse toward an act of digging, and with it also an impulse to pronounce the "word" in this its primitive form.

It is clear how much more stable was the "word" than that "content" which was formed by it. Nevertheless, of course, all this was still a relative stability. The nervous-muscular reaction itself, creating the word, does not occur each time in absolutely the same way, but with definite changes under different conditions; that is why the sounds of words also change; on such changeability the entire historical development of languages is based; the selection acts in such a way that a definite change in the original root is bound with a definite change in the complex of notions which is "conveyed" by it. The degree of this and that changeability is *different* – it is considerably lesser for the word than for the secured content; and this is exactly what is needed for degression.[1]

The most extensive and at the same time the most plastic system with which cognition may deal is the system of experience in its living, unfolding whole: the totality of things and images, accessible to the exertions and thought of mankind and to its organizing efforts. The content of this system is constantly changing: each moment brings into the field of experience new combinations of activities carrying away certain former ones. The "external environment" of this system is all that has not been achieved and is unknown, and all that still lies outside human effort, perception, calculation and foresight; our world, the world of physical and psychic experience as a whole, expands in the collective struggle with this environment and in the process of our conquest of this environment. And it is never possible to envisage either the extent or the significance of the new things that will enter the field of labour, to what elements the investigation will reach, and what combinations and forms will be created. It is clear that degression is indispensable for such a system– a degression which would be able to fix both the old and the new, and which, while not permitting the entire content of *our experience* to dissipate in infinity and uncertainty, would expand itself together with the environment, indefinitely and limitlessly, as much as it may be necessary. The *spatial net* and the *ladder of time* are exactly such universal forms of degression.

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[1]When a nervous-muscular word reaction occurs at a weakened level, sounds may not appear at all: the word is not "pronounced," but is only "thought" of, and is inaccessible to other people. Thought is internal speech. Its elements –"concepts" – are, consequently, also degressive, "skeletal."

Space creates a kind of indissoluble net from threads and abstract lines, going in three basic directions (length, width, height) and constantly crossing each other. In the loops of this fabric are placed, receiving a definite location thereby, all sorts of things and images, similar to geographic representations which are located on a map in the loops of an indexed net. Time is represented in the form of a continuously rising ladder with countless steps — moments; each of them serves as a support for securing facts and events. What is not related to this net and this ladder is lost for human experience, dissipates and is irretrievably lost, as are lost forgotten dreams.

In order to reach a universal scale, this and that degression must unfold without limit. How is this realized? Through a *periodic structure,* i.e., a homogeneous repetition of correlations. Two neighbouring loops of the spatial net are tied together in exactly the same way as any other two neighbouring loops; two successive steps of the ladder of time — in an identical way as any other two successive steps. With such a form of organization new links can be added to it in all directions without end.

But from this another, special uncertainty and instability must spring up. Homogeneous, repeating correlations are in themselves *indistinguishable* for human consciousness; and if they are intermingled for it, then the plastic content of human experience must also merge and dissipate. Consequently, for this universal egression still another egression is also necessary, which would fix it and give it a strict certainty; i.e., the egression of a higher order. If space and time are the skeleton of living experience, then this skeleton needs a backbone. It is necessary to have stable and immovable lines in space and in time — a firmly established moment from which to depart and to which to refer, as if securing everything else with their aid. These are so-called *universal coordinates* of space and time; such, for example, are the lines of north-south, east-west, up-down, the moment of the "Birth of Christ," or any other "era," in every-day experience. Astronomy establishes scientifically similar coordinates; for it, the haven of immovable stars and the regular motions of cosmic bodies serve as such a firm base. In the memory of mankind the outlines of star clusters have not as yet changed noticeably—so insignificant, although enormous from our point of view, is the speed of their motions when compared with their collossal distances that the structural lines of this system are for us practically unchanging. On the other hand, if we take the mutual location of planets, the Sun and the stars at any moment, then it will not be repeated in strictness ever again; this location can also be taken as a definition of one stable point in the chain of moments in order to calculate other moments from this point in both directions; and it will turn out to be an "era" of a precise calendar. Any point in space and any moment in time is bound with the universal coordinates by means of *measures* which are used to calculate distances between points and intervals between moments.

Such is the scientific, i.e., collectively worked out human system of coordinates.

And their first, initial system for any individual organism reduces to the basic directions of the body itself. The constancy, however, of these directions depends on a stable mutual position of parts of the body; and this stability is determined by the structure of the skeleton; and for man, in particular, the main coordinate, a vertical line (up-down), corresponds to the normal position, depending on the anatomy of his spine. Consequently, our comparison of the universal coordinates with it is not an accidental, single metaphor; it is, indeed, the biological origin of our universal coordinates of experience and their vital prototype.

Various elements of substance and energy constantly enter our organism and constantly are removed from it. In this continuous, agitated current the storage and accumulation of any activities are only possible thanks to the skeletal tissues which fix them and support the form of the whole body; without these tissues the organism would have disintegrated just like a river when it is deprived of its hard bed. Into the system of experience newer and newer elements of activities also continually enter from the ocean of the inaccessible and the unknown surrounding it; and other elements depart from it thereto. No storage and accumulation of experience would have been possible, and our entire experience would have dissipated into chaos, if every content were not fixed in experience by a linkage with definite points in space and moments in time, and if it were not put into ready, firm frames of this universal skeletal tissue, which is more durable than steel and diamonds, with all the "perfection" of their structure.

4. The Development and Contradictions of Degression

Let us investigate a typical development of degressive systems. Each such system consists, as was explained, of two parts: a more organized, but less stable part in relation to certain destructive influences; we will denote it as a "plastic" part, – and a less organized, but more stable part; we will denote it as a "skeletal" part. Let us assume that the entire system is generally under conditions of positive selection; how will it change?

If there are no special conditions particularly favourable to the skeletal part then, evidently, the processes of growth and complication will be stronger and faster in the plastic part which is more organized and better able to assimilate; the skeletal part, which is less able to assimilate, must then *lag behind*. Their former equilibrium, consequently, is disturbed: the "skeleton," binding the plastic part of the system, aims to contain it within the framework of its form, and thereby to retard its growth, to *de-limit* its development.

This theoretical conclusion is quite justified in reality; there are numerous examples of this in all the fields of experience. So, it is exactly the osseous skeleton which is the basic reason for a halt in the growth of the entire human body: when the bones fully harden ("ossification" of main parts of the skeleton), then they almost cease to develop;

and the plastic tissues, attached to them, are hampered thereby in their growth, which now occurs within narrow limits, and having reached them it stops. The brain, for example, being contained from all sides in the skull, which ossifies to a significant extent quite early, increases in its mass more slowly then other plastic tissues, although it has a higher organization than they do, – and develops predominantly in the direction of complexity. The skull of a gorilla ossifies even earlier and is distinguished by a tremendous firmness: it is much thicker than our skull, and where we have "seams" which slightly enlarge the plasticity, the gorilla has thick and high bone crests. Because of this the growth of the gorilla's brain stops at quite an early age, and the size of its brain is comparatively smaller than in man, several times smaller. The external skeletons, chitinous and corneous covers in many insects, crustacea, and vertebrates, lagging behind the plastic tissues in the process of growth, begin to vitally hamper them; then these casings must be broken and replaced by new and more spacious ones, which usually happens from time to time. With certain snakes a single or several rings of the snake's former slough remain while the body continues to grow; these rings progressively squeeze the body, not only because of the lack of stretching, but also because of drying up and compressing; then the snake perishes due to the loss of connections with the mechanism of nutrition.

The same is true in other fields. The clothing of a baby does not grow with his body; it expands a little at best, and then increasingly hampers his movements or tears. A dwelling does not enlarge with the growth of its inhabitants; hence, by the way, spring up all the cruel consequences of the congestion of people in large cities. Also, a vessel does not extend with the addition of a liquid; and even if it extends as, for example, does a rubber vessel with its elastic walls, then it still hinders the accumulation of liquid by its pressure, or stops its inflow at a definite level, or bursts. Similarly, a hard river bed, the natural vessel of the flowing water, opposes the increase of the water mass; the tighter and more abrupt is the river bed, the greater is the opposition, i.e., the more degressively it embraces the water. Moreover, an increased inflow of water leads to a growth in the speed of its current, i.e., to a more energetic removal of water; at the same time, the destruction of shores becomes more intensive. In this destruction the contradiction of systemic development between the plastic and "skeletal" parts of the complex is expressed. The ice cover intensifies this contradiction by making the degression more complete and more closed; the spring flood graphically reveals it by breaking up the restraining ice, as the growth of the snake breaks up its slough.

An especially important and interesting case present social degression– the realm of "ideologies."

We have seen that symbols in general, and their main group, – words and concepts – in particular, perform a skeletal role for the socio-psychic content. All and any ideology is formed from such elements and symbols of various kinds: opinions, theories, and dogmas, just as rules, laws and other norms are formed from words-concepts; artistic complexes are formed from special symbols of art. Consequently, the nature of ideologies is generally degressive, skeletal, with all the related features. This is supported at every step by concrete investigations.

So, beginning with the simplest example, the word not only secures the living content of experience, but also hampers the future development of experience by its conservatism. In science and philosophy, the customary but obsolete terminology is often a serious obstacle to progress, preventing the mastery over new material, and distorting the meaning of new facts which it cannot express fully and precisely. But this contradiction appears even more vividly in the development of more complicated complexes – ideas, norms and their systems. The term "ossification of dogma," which is used in relation to religious, scientific, juridical, political and social doctrines, is not in vain borrowed from the physiology of the skeleton: their lagging behind in the process of evolution from the living content of life; their retarding role is tektologically the same as that of any other skeleton.

Dogma is a system of theoretical ideas and norms, embracing a certain living content, a definite sum of cognitive and practical material. Thus, the dogma in religious systems, at first verbal, and then fixed by sacred books, formalized the historical experience of nations and secured their mode of life, their economic and political organization, and, often, even the methods of technology. All this was contained in the religious dogma, and all this was changing, of course, much faster than the dogma itself. There occurred a divergence between it and life, and its conservatism restrained and retarded the development of life, as did, for example, the catholicism of Europe during the Middle Ages and the beginning of the New times, the orthodoxy here, and the biblical and talmudistic dogma – to this day among the mass of Jewish people. The new living content, bursting out of the framework of the old dogma, created new degressive forms for itself: along with the religious systems of ideas and norms there were worked out scientific and philosophical ones. The former dogma, separating itself from the growing practice and experience, was thereby deprived of nourishment and atrophied; the new systems captured all that was more and more vital, and the old content, which was thus partly absorbed and partly made obsolete, disintegrated. For example, for a catholic of the Middle Ages, the scriptures determined cosmogonical, astronomical, and generally, biological views, etc.; and in our time even the most devout catholics, more or less educated, adhere to scientific ideas and theories in all of this; the dogma of the scriptures in these fields of knowledge became, as it is usual to speak, a "dead letter," i.e., symbols without content, an empty and dried up membrane. Cases were also observed, such as the divine worship and sacred books of the fire-worshipping Persians, when a part of the symbols lost through distortions and oblivion any meaning, and no one, not even the custodians of the ancient dogma themselves – the priests – can understand, i.e, relate to them any, even the antiquated content.

In a similar way, a juridical or moral norm often loses its previous content: the progress of life not only advances the relationships which cannot be contained in it any longer, but also creates new norms which regulate the entire content relating to it previously together with a new content that has emerged; the old norm does not then bind, or binds very little that is vital; such, for example, is the preservation of positions which became "sinecures," idleness, – titles corresponding to vanished social functions– formalism in the conduct of business which had lost its significance, but which is practically restraining – that which is well designated as "lifeless formalism," or the "power of the dead letter," etc. And where new norms have not yet been completely formed or have not been adequately secured in life, then the obsolete norms may perform quite a destructive role for the growing life – as, for example, the laws of the now worthless, but continuing to exist governmental structure of our pre-revolutionary Russia, or the rules of morality of the lower middle classes under contemporary tendencies in the family life of the working classes, etc.

There were cases when obsolete religious and political forms had arrested the development of entire societies, and even led to a prolonged decay of entire countries. In Spain of the XVII - XVIII centuries, the vestiges of catholicism and feudalism did almost what the remnants of the dead slough do to the organism of a snake.

So far we have considered cases when the system as a whole finds itself under the conditions of positive selection. The regularity is the same under the general conditions of negative selection: the plastic part succumbs more quickly to destructive influences, the skeletal, being more stable, lags behind. For example, with the intensifying exhaustion of the organism, the internal and external skeleton is still preserved for some time in almost the original form. Also, with a gradual decline of organizations of a social type, their formal aspect decays more slowly than its vital content.

Such are the systemic correlations in the development of degression. We see that contradictions are tektologically inescapable here, and that they emerge from the very nature of degression. It is possible, however, to reduce them to the lowest magnitude, and to constrain the waste of activities within the framework of what is absolutely necessary through the knowledge and understanding of their significance and regularity. It is here that systematized tektological knowledge is required.

Thus, in the field of social degressions – political forms, legalistic and other norms, and various doctrines, etc., – tektology will allow an objective investigation of each case with respect to the content which a given degression has organizationally secured from the very beginning, the preservation and changes in this content, additions and subtractions from it, the correlation of a given form with a given content, the possibility of another form more suitable for it, and the firmness of the former form and the timeliness of its destruction, etc. During this practical, scientifically based directives automatically emerge.

Tektological knowledge can be applied even more broadly to organizations which are structured formally and systematically, such as enterprises, unions, parties, and scientific establisments in our time, etc. Regulations or rules of order, official programmes, and technical or tactical directives, etc., represent their "skeletal" forms. While these forms are being worked out, the question ought to be posited concerning the degree of their elasticity, and the ease of changing them with subsequent growth and development of the organization. Usually this is not done, and consideration is given only to the firmness of forms and their conformity to the immediate problems of the organization. As a result there may later occur quite severe contradictions of the skeletal conservatism – a severe expression of the power of organizational laws, hanging over people as long they themselves do not master these laws.

The upbringing of children is the field where the lack of knowledge of degression is particularly telling. Here tektology must provide important and broad practical instructions.

So, contemporary upbringing introduces into the psychics of a child many ideas and norms of a special kind whose purpose is not to provide directions for his future active life, but only to facilitate and simplify the work of educators themselves. Here belong, for example, imaginary and sometimes deliberately false explanations which are given to children because of excessively complex or ticklish points, and many rules of behavior which would have been unsuitable and even quite harmful for adults. These are "temporary" skeletal forms for the youthful soul. Obviously, scientific ideology should reduce them to a possible minimum, if it cannot remove them altogether; and then it is obliged to take care of their timely removal, so that they will not be implanted more than necessary and have time to ossify. This will help to avoid a great waste of energy in the subsequent development of the child.

So, for example, the child is told not be secretive, or that he should never tell a lie. This is convenient for educators; but in contemporary reality a man is doomed to perish if he is unable to hide his feelings in many cases, and also at times to lie expediently. The educator should begin to soften these rules appropriately ahead of time, and take the initiative to limit them in a way which would not lead to demoralization, i.e., would not disorganize the social aspect of the child's psychics. And to this day, even if this is sometimes done, it is not at all done in the interests of the child, not out of concern for the future waste of energy, but for petty, practical considerations; for example, the child is told that for the sake of uprightness he should not speak unpleasantly to adults. How often parents, admiring the purity of the soul of their children, do not even imagine how costly this purity will turn out to be to the youth at the first coarse clashes with life — what storm of anguish and disgust with himself will be caused by the first forced violations of the too well-learned norms.

Another extraordinarily common error is the implanting of modesty in children and chastity in juveniles — in the form of an absolute character. Crises of sexual development are excessively aggravated through this: a break-up of the moral skeleton to the physiological shock is added.

Upbringing must generally aim at the greatest flexibility and elasticity of the degressive forms of the youthful psychics. There are various means of doing this; one of the main ones is an early introduction of historism into the system of instruction; the use of vivid and graphic historical illustrations. By carrying himself mentally into the cultural life of distant epochs of the past and alien nations, the child learns, at least partially, to put his experience into a framework which is different from that created for him by his environment and provided by the school. This prevents a complete ossification of the acquired ideas and norms, and facilitates their transformation when this becomes necessary.

Such examples clearly illustrate the tremendous practical significance of the law of degression. In fact, no lesser is its theoretical significance; this can be illustrated by one of the moments of the analysis already performed by us. It was sufficient to explain that ideas, norms and political institutions are, in essence, degressive forms for the organization of vital activities of society, and, as conclusions, certain principles have emerged which can be used as guides in socio-historical investigation, and which were acquired before with great difficulty in other ways: (1) all these forms ("ideological") *depend* on the vital activities of society ("socio-labouring"), and are determined by them; (2) in the process of development they are all more *conservative* than their socio-labouring content — a plastic part of the social system; they are preserved even when it has already outgrown them; and the time will inevitably come when they will become a constraint and an obstacle to its progress, so that their break-up and destruction become an organizational necessity. The regularity of social revolutions in this sense turns out to be homogeneous with the regularity with which the snake must from time to time shed its skin.

5. The Relationship of Egression and Degression

These two organizational types are by no means in oppositon to each other, as may appear at first sight; the egressive center is far from being always more plastic than its periphery — often it is even more conservative than the periphery; the fixing of activities is not in opposition to their concentration — on the contrary, it is frequently one of the necessary conditions for such concentration. The correlation of both types can be best of all explained by cases where the two actually unite. In this regard, "authoritarian" forms of social complexes are especially important and interesting.

"Authority" is not simply an egressive center of some organization of people, not simply its factual leader. Let us take the following case: a group of travellers follows a guide toward a definite point. Within limits of the problem, the guide is an egressive center; his movements determine the path for others, but, of course, if we designated him as the "authority," this would have been a metaphor only: in historical evolution of authoritarian forms, this word means something more than that. The patriarch of biblical times — the first type of "authority" — not only directed the life of his commune practically: all acknowledged that he had a special *right* to do this, and that he was the *power;* his role was fixed in concepts and norms of the communal ideology, in the thought of the commune and in its customs or morals: the "patriarch knows and orders"; "all must obey him." Obviously, this is an egression united with degression; here the direct connection of the organization is anchored by the ideological skeleton, which gives it great firmness. This gives rise to an entire series of interesting, social facts which cannot be explained outside of our point of view.

So, in patriarachal communes it often happened that the old patriarch, burdened with age, was already unable to direct the entire labouring life of the commune, or that he simply became senile. Another chief-organizer was put forward as his replacement to perform the patriarch's former practical functions. The former egression was replaced by a new one, but its ideological skeleton could not be destroyed so easily; it was too firm and too well secured by decades of authoritarian submission. The old man continues to be, for kinsmen and even for his actual successor, a central figure and a higher, more honourable head of the commune. In essence, this is simply a symbol of the unity of the commune. The commune grows, its membership changes, its territory spreads out, and the relationship of blood kinship becomes less close with each generation; but as long as the forefather lives, he continues to embody in himself its organizational unity. He performs for the commune, approximately, the same role as not so long ago, and perhaps even sometimes today, a banner performs for the fighting collective. When during a battle the communications of a detachment break-up, then its uncoordinated units direct their efforts so as to make their way to the point where an old scrap of the shot-through cloth is flapping; this degressive unification complements and strengthens the living egression, with its real center in the person of a leader. When living combinations give rise to contradictions inside the commune and undermine its unity, then the eyes and thoughts of kinsmen are directed to the old symbol of this unity: in the presence of the patriarch the fits of hostile tempers subside, conflicts soften, and the concilliatory action of the real organizer now encounters a lesser resistance. Thanks to the conservatism of ideology, the old authority is "higher" than a new one for everybody.

The process continues. The ideological skeleton remains even when the old patriarch has already died. There is a continued obedience to his legacies, and his will is cited by the successor. Although the patriarch had died, the guiding power, his "authority," is preserved and, besides, this authority is higher than the authority of his successor. And when the successor also dies, his authority, in turn, is again held to be higher than the authority of the leader who replaces him, etc. In this chain, the authority of the dead is in this way raised above the authority of the living, the more so, the further it goes back into the past. The most remote ancestor whose legacies are still passed among the living generations, develops into a gigantic, superhuman, authoritarian figure: into a deity. Thus, from the real authorities, through the preservation of an ideological skeleton enveloping egression and remaining like an empty membrane *imaginary*, symbolic authorities of religious ideologies arise after their death. At the same time, this posthumous preservation of authorities gives rise to a myth about the immortality of the "soul": the soul is, so to speak, an organizational side of the human being, his guiding function; because of this, only the souls of patriarchs and leaders have immortality initially; and only later, with a division of the organizational role and with the development of a chain egression in society, immortality is gradually spread to the souls of other people. [1]

Manifestations of the growth of egressive variety, and ossification of degressive complexes, such as symbols can also be clearly seen in the growth of imaginary religious authorities. Gods grow and recede further and further from people; but at the same time their role becomes increasingly more conservative; their authority squeezes and constrains vital life, as long as life does not throw this authority off as the snake sheds its skin.

Thus, we see in religion with its deities an imaginary egression; in fact this is a degression, i.e., ideological complexes which arose on the basis of actual egressions. But in contemporary thought this kind of a tektological illusion spreads even further, to most ideologies: contemporary thought believes that ideas, norms and institutions generally "rule" over the life of society, i.e., organize it in conformity with egression and not degression. What is the origin of this illusion?

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[1] At first this is, generally speaking, not immortality, but only a posthumous life of the soul, more or less prolonged, after which the soul also dies: you see, sooner or later the memory of the ancestor-organizer also disappears, his guiding legacies die off and are forgotten... For more about this see my *Science About the Social Consciousness*, pp. 50-64.

The scale of contemporary thought is individualistic: an individual with his private experience. However, in the life of society the objectively guiding role belongs to the entire collective, to a general-social class, or a group collective. Ideas, norms and institutions bind the individual with the system of a collective; through them he submits to its united vital activities and its general tendencies; these tendencies are only "expressed," symbolized, and fixed in ideas, or institutions. Thus, the state "rules" over the individual, commands him and guides him; but the state does not rule over society, but only expresses and fixes the rule of some elements of society over others. The higher class in reality rules over the lower class; but the state with its legal norms only provides stability for this rule — represents something like a system of reins and harness for the direction of the lower classes. And, generally, ideological complexes "control" movements of an individual in the current of social processes according to the same type, being a means of introducing him into the framework, and subordinating him to a certain whole. If horses never saw the driver, they would have considered the reins to be a higher power controlling them, being their egressive center; so also a man, thinking individualistically and not seeing the real collectives with their vital activities moulded by ideology, considers this ideology itself to be a higher, controlling power — in a word: he mistakes degression for egression.

A system composed of a pregnant mother represents another combination of egression with degression. For the child, the mother's body determines the conditions of life and development; it is an egressive center to which both conditions are subordinated; but at the same time it is also a protective envelope, separating the child from the destructive influences of the environment; it is the child's living clothing, his external "skeleton." From the first point of view, the body of the mother must possess a higher level of organization in comparison with the body of the child, from the second, on the contrary, — a lower level of organization. How can this and that be reconciled?

The riddle is solved simply: the two different tektological forms have to do with different specific activities. The egressive role of the mother lies here in the sphere of nutrition, i.e., the extraction and supply from the external environment of matter and energy which are necessary for the sustenance and growth of life; in this regard the body of the mother is organized, of course, incomparably better than the body of the child, who is not even able to work independently in a given direction. The protective role, however, is connected with the plastic, moulding processes of the child's life: they go on with such an intensity that the child's body, continuously changing in structure, would be too unstable under the hostile influences of nature; too "tender" for them. In this respect, the mother's tissues should be considered to have a lower level of organization than the tissues of the child: the first have already come to a stop in their development and only preserve their forms; the second develop swiftly. The first are "coarser"; they can, therefore, perform the role of covers for the second. In particular, this purpose is performed by the uterus — a sack composed of a muscular, conjunctive tissue, obviously, a complex of a lower order in comparison with the body of the child.

This example is connected with an instructive story, which shows the skeletal firmness of forms of organizational thought and their sway over people. With a difficult birth there are sometimes cases when the mother's life can only be saved at the price of the child's life, and conversely. Who should be sacrificed then? No matter how strange is such a statement of the question, among the scientific specialist-obstetricians there were long discussions about this, accompanied by a multitude of moral and metaphysical considerations advanced by some in favour of one, and others in favour of another solution. The reason for this is now clear to us; it lies in the narrowness and one-sidedness of specialized thought; namely, some specialists perceived the systemic relationship of the mother and the child only from the point of view of degression, others also perceived egression. To the latter, the mother was an adult, the child an embryo; to the former the mother was a vessel, containing that which is of interest to the specialist-obstetricians, whose horizon is restricted to the problem of releasing the infant from this vessel. The narrower, the more restricted the specialist, the more he was inclined to the second solution.

Many other examples could be given of combinations of egression with degression, such as, for example, the ship egressively subordinated in its motion to the crew headed by a captain, but degressively containing in itself, as an external skeleton, the captain, the crew, passengers and a valuable cargo. All combinations reduce to two types: either degression occurs parallel with egression and fixes it, as was the case in our example with the authorities; or both of them relate to different specific activities which must then be precisely established and delineated.

What is the relationship between *universal* egression and *universal* degression? It is easy to see that it is of the first kind. Universal egression unfolds in a successive subordination of nature to mankind; universal degression secures each step of this process, determining and fixing it in space and time. The power of society over nature is real and firm only where everything is established and distributed in space and time; this is its first and basic fixing condition. A newly discovered country is actually discovered inasmuch as there are determined its geographic coordinates, i.e., its location in space; a newly discovered planet — only when there are established its astronomic coordinates and the time of rotation in orbit; a machine can only be directed through a precise measurement and commensurability of its parts in space and of its speeds in time; any labour and any cognition — egressive, subordinating nature activities — learns on the same degressive "orientation." In its conquering action mankind throws a spatial-time net on everything that is accessible to it, and the securing of each link in this net is a step to new victories.

VII
The Paths and Results of Selection

1. Selection in Complex Systems

We have seen that the mechanism of selection is universal; it operates everywhere and at all times; in other words, any event, any change may be considered from the point of view of selection, as the preservation or multiplication of some activities, the consolidation and reinforcement of some connections, the removal, reduction, weakening and a break-up of others in the same or another complex, in the same or another system. The factor, a catalyst of selection, is always the "environment" in the most general meaning of this word: as soon as we have singled out or isolated in some way a complex from among other complexes for the purpose of our study, we have thereby acknowledged that its preservation or destruction, its growth and development or decline depend on its correlation with these other complexes, on the extent to which their activities are counter-balanced or surmounted by its activities, or, conversely, on the extent to which the activities of a given complex are surmounted or disrupted. Systemic activities grow at the expense of the environment under positive selection; they are absorbed by the environment under negative selection. But the complex singled out can be, in turn, decomposed into its own "parts," smaller, component complexes, systems; to any such part, as soon as it becomes an object of a special investigation, the same point of view can be applied, so that the other "parts" will now be considered as entering the composition of the environment, etc.

Therefore, in the study of the development of complex systems such as, for example, a society, an organism, a scientific or philosophical doctrine, or a cosmic body, it is necessary to bear continually in mind the internal processes of selection of their elements; and if some elements can be decomposed further, into elements of the second order, then the internal selection processes of these elements must also be considered in their even narrower environment, etc., as far as the achieved level of analysis permits. We have already applied this point of view in many cases; for example, it explained such paradoxes of development as the better health of an organism after a sharp illness than it had before the illness, or a particularly fast flourishing of society after a crisis or after a difficult war. The destructive action of negative selection removes, first of all, the less stable elements and connections, and if this action is brought to a halt at a definite point and replaced by a phase of positive selection, then the surviving more stable elements are given a great scope to develop and multiply. In a similar way, we succeeded in understanding the decay of an old organism, and also the contradictions of systemic divergence, as being the result of unequal conditions of selection for different elements of the whole, etc. It can be said with confidence that not a single question of structural development can be resolved with any degree of precision apart from this universal application of the idea of selection, which permeates all the levels of existence.

One of the important conclusions of such an application is the principle of "chain selection." Let a complex system A— a crystal, a living body, psychic association, or a society— be under the influences of a definite environment which change it in this or that way; these changes are continually regulated by selection, and the complex is transformed in accordance with the environment, "adapts" to it, in the words of biologists. During this process, different parts of the complex are not transformed immediately, but one after another, in a definite succession. The basic character of this succession is not difficult to establish theoretically by quite a simple analysis.

Let us decompose the whole into parts in the following way: let us identify the "frontier elements" which are, in the first place, connected with the environment and which are directly subjected to its influences; then those elements which are most closely connected with this front row, etc., going "stratigraphically" from the outside to the inside. This can sometimes be in fact stratigraphical, in the spatial sense, for example, when a solid body heats up or cools down from the surrounding environment through conductivity; but it can also be otherwise, for we know that the tektological boundary frequently does not coincide with the spatial boundary, and in many cases it is not at all expressed geometrically,— for example, when the matter concerns a psychic association, or an ideological system, etc.

Since the factor of selection is the environment, it is evident that its transforming action will be felt first of all in the frontier "layer" of the system, which must directly adapt to the environment, understanding this term in the broadest and not only biological sense. This first order of changes represents a changing influence for the second "layer," that— for the third, etc., on to the elements which are tektologically innermost and indirectly experiencing the influences from outside the system. This sequence, both necessary and simple in its obviousness, serves as a basis for important inferences which in themselves appear to be neither simple nor obvious.

Let us consider from this point of view the society as a system of human activities in the midst of elemental nature and the struggle with it. One part of these activities is directed straight at the complexes of nature, at its objects and forces: those labouring efforts which have a technically productive character, and whose connections constitute technical devices and methods. This is, consequently, that side of social life with which the society comes directly into contact with nature: the realm of "frontier" elements of social processes. Here *primary* processes of selection and adaptation go on, on which subsequent changes in the course of the life of society depend: the initial point of social development or its bases turn out to be technical forms.

The next "layer," of course, in a tektological sense, forms interactions and mutual relations of labouring activities: the relations of people in a socio-labouring process, production relations, or the field of "economics." In other words, economic forms are determined in their development by technical forms.

The high plasticity and complexity of both forms give rise to the necessity for their organizational fastening, i.e., their social degression. This is, as we know, the field of "ideological" forms. Evidently, they constitute the third layer, a "superstructure" in the expression of Marx, and are determined in their development by the first and second group of forms.

So, the most important and still debatable formula of historical materialism for the old science is tektologically reduced to a simple conclusion arising from the same regularity, by virtue of which, for example, the heating of inner layers of a body through heat conductivity depends on the heating of external layers, etc. It is clear that the formula is applicable not only to a human society but also to any group of social animals— whether they are social insects, flocks of birds, or herds of mammals. Let us take as an illustration a probable path of development of a herd-connection among wolves.

Wolves, similarly to some savage tribes of people, live by hunting: such is the technical process of their struggle for existence. The species relationship among the wolves or their families can remain at the level of minimal intercourse without assuming the form of a pack, so long as the main object of the hunt are small animals which can be advantageously hunted by a single wolf. But due to either climatic changes or competition with other predators or, finally, the excessive extermination of this small prey by the wolves themselves, its supply may become inadequate for them: conditions of the environment change, and it becomes necessary to hunt bigger animals– a new technical problem arises, requiring a different expenditure of efforts and different methods.

Let us assume that there are large herbiverous animals: a bison or a wild horse, which used to live in our parts of the world. A single wolf cannot cope with a bison, cannot catch a horse: the problem is solved only by the development of a pack collaboration, i.e., a new productive relationship, – a change in technical conditions has led to a transformation in economics. Here it unfolds step by step. If wolves hunt in a larger pack, then the requisite correlation of their efforts cannot be achieved without direction: rushing at the prey in a disorderly crowd, they will partly hinder each other, expend a lot of extra energy, and somethins also suffer defeats, especially from the herd animals. A leader is singled out of necessity – an old, the most experienced wolf. He distributes the roles; for example, he assigns a part of the pack to an ambush, a part to the role of prey-drivers, and himself gives a signal for an attack, etc. Roaming in an entire pack in search of prey is quite inconvenient: therefore, special scouts are sent out, a germ of still another form of division of labour.

Depending on this first layer of economic relationships, forms of collaboration, the second layer must also change: forms of distribution or appropriation. One cannot grab as much of the prey as one wants; common prey must be divided equally, and if, for example, those in ambush were successful in seizing a deer, they must wait for the prey-drivers or leave their portions untouched: a transition from an individual appropriation to an elementarily-communistic appropriation.

Subsequently, complications of technical modes and productive relationships require the development of a system of signals and the working out of new signals which are not needed with just family relationships and individual hunt. The leader must have at his disposal a sufficient number of methods in order to indicate to parts of the pack and to its separate members their role in the execution of the common task – some of them must be sent out, for example, as a reconnaissance party, others, when the prey has been spotted, must drive it, still others wait in an ambush; further, the leader must have signals for an attack, retreat, and halt, etc. The selection is aimed at the creation of organizational instruments which are analogous to human speech, although these instruments are much less perfect. Each signal, a special cry, or a howl is similar in its function to the word; and when it exists in the consciousness and is not expressed externally, for example, when the leader observing the run of a driven prey awaits for the moment to give the ambush a signal to appear on the scene, and until he holds, so to speak, this signal in his head, we have before us a phenomenon corresponding to "thought;" as we see, even here the ideological "superstructure" must develop in conformity with technical and economic conditions.

Such a sequence of selection in complex systems, from tektologically-frontier groupings and connections to tektologically-inner groupings, can be denoted as "chain selection."

Let there be at one point of a system— for example, the system of production,— a change in its frontier elements, for example, a development of a new technological method, a new instrument. This gives rise to corresponding economic regroupings which are secured in new ideological complexes as a new experience: the improvement is carried into the system of knowledge, science. But ideology, in its turn, is the organizational environment for the *entire* economics, and *entire* technology; consequently, here the line of chain selection and adaptation may now begin from new ideological complexes: a reorganization of economic and technical processes in those parts which were not yet touched commences; in conformity to them through scientific acquaintance, a new method or instrument which was applied only in one or a few enterprises, spreads throughout the entire industry, and also, perhaps, with some changes into other industries kindred in technology.

It is also clear that this line of adaptation in no way contradicts the idea of a chain selection: instead of going sequentially from the third organizational layer to the second, and then to the first, it went from the first to the second and to the third, which is its beginning. The guiding thread of the investigation remains the same: any change in a system has a point of departure where the system comes into contact with the external environment; "in the final analysis," it is exactly there that any process of development originates; this expression of Marx in his formulation of historical materialism has precisely this meaning. We gave examples of how a much too firm ideological degression had brought economic and technical progress to a halt (the catholicism and absolutism of Spain in XVII. XVIII centuries, etc.); but this ideology itself must have been formed before on the basis of a definite, conservative economics and technology,— on which such historical facts depend in the final analysis. The same general scheme is also applicable to any changes inside any complicated system: with sufficient study, one can always find a point of origin and the initially determining primary conditions in the area of frontier elements, i.e., the area of their interactions with the environment. For example, the most unexpected ideas and thoughts, springing up without any visible cause, have their beginning, through a chain selection, either in irritations of organs of the external senses, or in the action of organs of nutrition, assimilating energy from outside. There is no place for any "spontaneity."

2. Selection in Changing Environment

As we know, an absolutely stable and conservative environment does not and cannot exist; however, tremendous differences are encountered in the degree of its changeability, and, therefore, there is a basis for juxtaposing the conditions of selection in a conservative and in a relatively variable environment. For example, the social environment of our revolutionary epoch has changed during a few years or even months to a greater extent than during the proceeding decades of the usually "limited" development of capitalism; but during the feudal epoch, its transformation on a similar scale required centuries, and during the early patrimonial epoch— tens and, probably, even hundreds of centuries. Geological development and cosmic processes also represent phases of relatively slow and relatively fast development— sometimes unmeasurably rapid variations. It is clear that the *direction of selection*, on which the emergence of forms depends, is relatively stable in a conservative environment; in a variable environment, on the contrary, it proceeds changeably, now in this and then in another direction. This is inescapably reflected in the tektological type and character of the created forms. The more conservative is the situation, the longer the action of selection proceeds along the same invariable directions, the more perfect and complete turns out to be the correspondence of the produced forms with exactly this situation, and the more fully is achieved their equilibrium with it. But with this, their structure of necessity turns out to be also conservative, devoid of plasticity. A higher degree of correspondence to a given environment means a lack of such correspondence with respect to a different environment; and any subsequent changes in the situation must be destructive to the same extent if they occur at a relatively accelerated speed.

We do not know the exact causes of extinction of the ancient giants— the jurassic lizards or, closer to us, the mighty predators and herbivora of the tertiary epoch. But a quite sufficient cause may have been simply the replacement of a prolonged period of a stable biological situation, during which these species evolved to their rough perfection and stopped there, by a period of faster changes in the environment, to which the hardened forms could not successfully adapt. And their successors, it can be assumed, were promoted by those regions of the terrestrial globe where the objective conditions of life were less stable previously, where the changeable line of selection had already laid down before this a beginning to various directions of evolution and created initial points of departure and embryos to many of its possibilities and a subsequent living struggle.

It is necessary, of course, to remember that the environment is the sum of external relationships of a complex, and that, consequently, at one and the same place the environment may be quite different for dissimilar complexes— for some conservative, for others variable, inasmuch as they themselves relate to it differently. All contemporary species of animals have an environment which is more conservative than the people living there, because their *perception* of the surrounding conditions is incomparably lesser and their *reaction* to these conditions so much less varied. Animals, just as man, in their struggle, in their interaction with external nature, change it— but they do this so much less than man! That is why the direction of selection for them is immeasurably more stable than for man, and so elusively in its sluggishness proceeds the transformation of forms of their life in comparison to what is being observed with people in their social environment.

The interaction of social man with external environment takes place in the technical process of production. Therefore, conservatism of the technical aside of life conditions the conservatism of social life in general, since it denotes stability of environment, the stability of the basic line of selection. We saw that economics and ideology depend on technology in their development,— and that they are, consequently, conservative in this case— but ideological forms being degressive are, evidently, conservative to a greater extent than any other forms; from historically known social systems, authoritarian systems are characterized by the greatest conservatism, which is seen in communal and tribal groups of a patriarchally-ancestral mode of life, feudal and eastern-despotic organizations; but technical progress is peculiar to formations based on exchange, and, in particular, to capitalistic systems. Of course, in the groupings of the first type, development is also being accomplished, but only much more slowly; its path lies, as it does in the systems of the second type, through the struggle of trends which form a broad field for the social selection. If we compare how these trends are organized in their struggle, then we will find for the two cases a definite distinction in the forms of groupings: for the first, their type is a religious sect, for the second, it is a political party. History shows that the first type always tends to an organizational ossification; even if the sect introduces into life something new and progressive, it envelops this material by a stable membrane of dogma which is accepted as something final and immovable; struggle and progress are admitted only up to the victory of this dogma. On the contrary, the second type embodies its tendencies into relatively plastic forms— programs which may change in the course of a struggle and expand with a victory. The objective significance of both the sect and the party and the objective content of their dogmas and programs are homogeneous: a struggle for the interests of these or other social groups or classes, and adaptation of the social whole to those interests. With the transition of society from a conservative to a plastic structure, the former sects at first change their character, approaching the party type, and later disappear altogether as an organizational form, because they are not adaptable in essence to the changeable technical and, generally, social environment.[1]

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[1] Details on the juxtaposition of organizational types of a sect and a party are in Tektology, Vol. 1, pp. 99-105.

There is an interesting case of selection under changing conditions, when changes in them are both quite significant and at the same time regularly periodic. Such conditions are created for the majority of animals by the astronomic cycle of day and night. In the struggle of animals for survival a decisive role is performed by the "motor reactions" of animals, their expediently directed movements; procurement of food, flight from danger and other means of self-defense, and also the attacking activity reduce to them. The expediency of all these reactions depends, in the first place, on the "orientation," directing the work of the brain, which itself rests on external senses, mostly sight among higher animals. Of course, the best orientation does not guarantee success and does not rescue one from harm and destruction when the environment itself is especially unfavourable.

What is the difference in the situation during the day and night from the point of view of complex animal organisms with developed sense organs? It is enormous in two senses: (1) on the part of the character of external activities with which one must deal; and (2) on the part of conditions of orientation. The latter distinctions are especially vivid and clear. The night light of the full moon is *400-500 thousand times* weaker than the day light. As far as sounds are concerned, on the other hand, their usual sum is so much smaller at night than during the day, so that innumerable small noises can be distinguished which were drowned in the general chaos of sound vibrations of the daily environment. These facts are sufficient in order to see the extent to which the line of selection must change in relation to orientation of animals with the transition from day into night. And for them all depends on orientation. Any, the most minimal inadequacy in it, means an inevitable death in a strenuous struggle, where so much is conceived and so little survives. It is clear that under such sharp fluctuations in conditions a complete and precise adaptation to both is impossible: some organisms must turn out to be more adaptable to one environment and predominantly unfold their activity in it, others,— to another environment. But this gives rise to another new, extraordinarily important divergence in the biological situation of day and night,— both for animals which compete for food and for those which are in direct conflict among themselves. For example, if large predators search for their prey mainly by night, it is easy to see the extent to which the daily environment is more favourable to herbivora, which are their victims.

However, both environments are equally inevitable. And if, for example, the man of the tertiary epoch with its virgin forests could more or less successfully orient himself by day and much worse at night, since his main means of orientation is sight, and, moreover, if even then the most terrible predators were likely to be nocturnal animals, — how could he then, having lived through the day, escape death at night?

We know that environment is correlative with the organism; the environment, consequently, expands and intensifies its influence on the organism inasmuch as the org*anism un-*

folds its activities in the environment; the environment narrows down and weakens its pressure inasmuch as the organism curtails its active manifestations. If so, then a solution to the problem of the dual line of selection springs up by itself: an escape as far as possible from the night environment, rolling up in it to a minimum, with the result being a sort of fencing oneself off from it. On such a basis selection worked out an adaptation which is widespread among the animal kingdom, namely, that of ***sleep.***

Sleep puts an end not only to the visible motion of the organism, but also to the perception of external senses and the work of consciousness. It would not be possible otherwise, since all these functions are inseparable from each other. Let us picture the same savage of the primordial epoch in the situation of virgin forests in the middle of a dark night, when he cannot penetrate the darkness, and where the eyes of predators flash and innumerable threatening rustlings can be heard; if he perceived all of this, listening attentively and peering closely into the darkness and shivering in his refuge, this would be a great waste of energy; and besides, how easy it would be for him to betray himself to the terrible enemies by not restraining his fears through a scream or a movement! Here "beneficent sleep" not only helps to save a great deal of energy, but also to reduce directly the threatening dangers.[1]

Analogously, if, for example, the owl adapted itself to the night environment, then it is exactly because it is helpless during the day, with the dazzling to its eyes light,— for it daily sleep is the same necessary adaptation.[2]

Under the same formula of adaptation to limited, changing conditions also falls hibernation of many animals, which could not adequately adapt to both the summer and winter situation, and are therefore forced to "depart" from the latter.

Thus simply is resolved, in principle, the question of the origin of sleep, which to this day is an object of scientific debates. Only the theory of Clapard, approaches more or less closely this solution. He considers sleep as a protective instinct, preventing an exhaustion of the nervous system from its continual activity. We saw that the problem here lies not on-

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[1]The "mystical fear" of the dark and night quite frequently observed among children and often also among adults is, most likely, an atavism— a survival of those sensations of helplessness and of an indefinite, threatening danger everywhere, which must have been experienced by primitive man under such conditions, and which cut deeply into his nervous system.

[2]As is presently known, our eye has at its disposal different organs for day and night sight: the coloured sight, the "cones," for the day and the scotopic vision, distinguishing only degrees of light, the sight of the rodes of the retina for the night; at that, the night sight is much more sensitive than the day sight; however, apart from the importance of colour for orientation, the difference in the intensity of light hundreds of thousands of times stronger cannot be in any way balanced by the difference in sensitivity.

ly in exhaustion, but, perhaps, even more in the conditions of orientation; hence the connection between sleep and the astronomical exchange of day and night, which is considered neither by Clapard nor by the authors of other hypotheses.

As far as the mechanism of sleep itself is concerned, this question, of course, is not solved by our theory. Here, the opinion of M. Duval appears to be the most probable. He hypothesizes that sleep is achieved by the separation of nervous cells of higher centers through contraction of their branched out appendices, so that these appendices cease to come into contact and suspend the active connections of cells which are necessary for arbitrary movements of the organism and for consciousness in general. Of course, the question should be resolved by experiments and observation, but other theories (obstruction of the nervous channels by products of vital decomposition— "skeletal" substances; ebb of blood from the brain, etc.), apparently, are so far less in agreement with facts. The solution, however, is generally-biological,— and at the same time tektological— it does not depend on the acceptance of either one or the other; such a solution is presented by us.

Human society, as a whole, with the development and branching out of production, adapts to an extraordinarily varied and changeable environment: each branch of production is distinguished from others by its situation and by its special correlation of human and elemental activities. But a separate member of society, due to individual limitations, cannot adapt to all of these correlations and situations: he "specializes" — a typical case of systemic differentiation. Together with this, a peculiar protective adaptation is worked out against all those conditions to which man is not specially adapted: he "avoids" them, "does not like" them— his reactions are directed so as to isolate him from the unsuitable environment. Thus, the farmer does not like city life, the scientist scorns physical labour, the professional soldier nourishes disgust against peaceful labour, and a specialist of one department often even "despises" specialists of other departments,— these are different expressions of reactions of repulsion, self-withdrawal from these or other types of labour, from their specific correlations with the environment. This adaptation is, consequently, analogous to the phenomenon of sleep in its function, no matter how little it resembles it; and in a similar way it presents the result of organizational limitations; therefore, it appears the more sharply the less plastic is the human type, the more conservative is the psychics; it appears most sharply in caste distinctions among the backward peoples and, analogously, among the most limited specialists of the newest civilization. It is evident that adaptation is similar to sleep and that it is imperfect: just as sleep makes man completely helpless against hostile forces, inasmuch as full isolation from them is not achieved, so too adaptation increases the unsuitability of the specialized being, inasmuch as the force of things may put him into unusual correlations and force, for example, the farmer to fight for survival in a city, or the scientist to take on physical labour.

One of the problems of the organizational development of mankind is to overcome the imperfection of such adaptations, which are created elementally by selection in a limited environment.

3. Direct and Representative Selection

We pointed out that man in his active development, in all of his labouring activity, appears unconsciously or consciously as a *factor of selection*: he destroys connections among complexes which do not correspond to the tendencies of his efforts, maintains and develops connections which are in agreement with him. These processes of selection are for us, of course, especially important, and we must study them more closely. First of all, it is necessary to distinguish between them and the usual elementally-proceeding processes of selection.

The basic difference is as follows: the natural environment always embraces from all sides those complexes which are objects of its selection; man, however, always only partially comes into contact with the complexes selected in this or that way, and represents only one of the elements of their environment, although at times the most important and decisive element. Hence it follows that there is: (1) a *limited significance* of this kind of selection, and (2) a special limitation in its very *direction.*

For positive selection in nature, i.e., for the preservation and development of a given complex in a given environment, it is required that the *totality* of environmental conditions be favourable; for negative selection, i.e., or the unsuitability of the complex in at least one respect to have a *single* unfavourable condition, unsuitability of the complex in at least one respect, to one part of the environment. For example, in order to exist, the organism requires a sufficiently high temperature, the requisite nutrition and an absence of known pathogenic agents— dangerous microbes, and an adequate distance or other barriers separating it from stronger enemies, etc. For the weakening and then death of the organism there is no need to violate all or many of these conditions: the question is resolved by absence of one of them. This explains what is known as the "wastefulness of nature:" extermination of a colossal majority of appearing forms, preservation and development of an immeasurably small part of them. Hence man also carries out so much more successfully the business of negative selection: it is much easier to destroy than to create!

Where man interferes, nature does not cease to continue its work. The fate of a complex, which he aims to preserve or remove, is determined as before by the *entire* sum of conditions, by *all* the influences of the environment; and the effort of man is only one of the components of this sum. Therefore, quite frequently, when this effort is directed at the preservation of a complex, for example, at the maintenance of life of a domestic animal or useful plant, along with this, as a part of elemental environment, an unfavourable condition leading to negative selection appears: the animal or plant perishes; for example, from an unexpected disease, from an attack of predators, or an introduction of parasites, etc. It can happen, of course, though generally rarely, that the efforts of man, directed at the destruction of a complex, are paralyzed by other conditions; although it is sufficient to have a *single* unfavourable condition for negative selection to succeed, the activities which form this condition may be subjected to disingressions on the part of other elemental activities, such as, for example, the force of a blow on the part of unanticipated resistances. In the facts of both a limited significance of "human" selection is revealed, as a partial and incomplete regulating mechanism.

The second moment, limiting now not only the success, but also the precision of the direction itself and the systematic character of action of this mechanism, is what we will call a "representative" character. Man knows what he wants to choose; nevertheless, he can in fact choose something which is not wanted. The most simple illustration is the separation of flour from bran and other admixtures by means of a sieve. Particles of flour, subjected to selection, are in essence complexes of a definite physical and chemical composition which are also distinguished by a definite magnitude. This magnitude is only one of their characteristics, and in the given case the magnitude is in itself the least interesting to people. But our technology is unable to select *directly* all the needed physical and chemical qualities; however, it can select this or that magnitude with the aid of a sieve: a typical instrument of selection, detaining all that is greater than its openings, and letting through all that is less than these openings. With the usual preparation of flour by grinding of the preselected grain, the magnitude of the resulting particles follows so precisely along the required physical and chemical properties that it can be taken as their *representative*; and then it is practically sufficient to select the particles of flour according to magnitude, with the aid of an appropriate sieve, – the result turns out to be what is needed in all other respects. So, the method of selection here is not direct, but indirect, through the instrumentality of one element, a sign, appearing, so to speak, as a representative for others, a sign "representing" them. Hence the name– representative selection.

Man cannot act in any other way precisely because his knowledge of things is limited and his practical methods dealing with them are also limited. Objects are accessible to him with a given level of technology only in some respects, and only to a definite extent, although with the development of technology this accessibility also grows. In our example, man needs to select a nutritive substance; consequently, according to his problem, the *basis of selection* is nourishment; but he is unable to capture and separate it directly. Instead, he takes a feature, which according to previous experience continually accompanies nourishment, and which is accessible to his methods,– the magnitude of particles; this is his practical basis of selection. So far as conditions in fact correspond to the previous experience, and so far as connections are as he assumes them to be, his goal is achieved; however, so far as conditions may be different, the representative selection is inadequate, or even basically wrong.

So, for example, if the grain when ground contains an admixture of sand or some other litter, then all of this, fully or partially, will go through the sieve, since their particles are of the same magnitude as the particles of flour; they are not distinguished from the particles of flour representatively, although they do not possess any nourishment; the method of selection is inadequate. And if in the grinding "hornlets" of spurs, or other poisonous substances are admixed, then the result may turn out to be quite contrary to the task; the selected material will be harmful, and even disastrous for consumers.

Extraction of gold from deposits reduces to various methods of selection. The simplest method is washing away by the water current in special basins and chutes; here all the properties of gold are "represented" by its high specific gravity, and because of this grains fall to the bottom, whereas the remaining lighter substances, entering the composition of gold sand, are removed by water. Evidently, however, other heavy particles, metallic and non-metallic, will also fall to the bottom with them. If the sediment is subjected to a new treatment— by mercury, then the gold will be separated through dissolution from the rest of elements; however, if there is silver, it will also be dissolved, as will some other metallic admixtures. By evaporating mercury through strong heat— a third process of selection— we will get a deposit in which the properties of gold are represented by the solubility of mercury; as we can see, imprecision is possible also in this case; for example, instead of gold, we will get a combination of gold and silver. Still another method of selection— the action of sodium nitrate— will separate gold from silver and the majority of other metals, if they are present, because they will be dissolved in it, but not gold; however, platinum and some other rare metals are also not soluble, so that the chemical purity of the product is also not guaranteed even here, etc.

In the first stage of the whole process, the basis of selection, as we see, is the specific gravity of gold, in the second it is joined by the solubility of gold in mercury, and in the third— its insolubility in sodium nitrite; and with this *expansion of the basis of selection,* its results become increasingly more precise, increasingly more corresponding to the task. And this, of course, may be considered, as a general rule, as a practical and theoretical principle in the application of selection: *the broader is the basis of selection processes, the more definite and strict are its results.*

This point of view is especially important where objects of selection are the most complex systems, such as living people. The biblical "problem of Gideon" may serve as a vivid illustration of this. Gideon had to march, with quite an inadequate and hastily assembled army, against the Philistines who had attacked Israel. It was quite evident that engaging in a direct open battle would have meant an inevitable defeat. The only possibility of victory lay in the attack on enemies at the moment of least resistance, i.e., completely by surprise. For such a solution a much smaller army than that present would have been sufficient, provided it were composed of courageous and energetic soldiers; but how with at least a few hundred soldiers is it possible to steal through undetected to the military camp, guarded by sentries? It is clear that for this were necessary people of special endurance and patience, able for hours with the greatest caution, not betraying themselves either by sound or imprudent movement, to steal up to the enemy in the darkness. Gideon, therefore, decided to carry out a strict selection of his soldiers on the basis of courage and endurance.

At first, he offered to all those who wished and thought that they had important matters at home, to leave in order to settle such matters. Of course, the timid and the insufficiently patriotically minded took advantage of this opportunity; the greater part of the army scattered; but those who stayed behind were the most courageous and reliable. Subsequently, Gideon took them for a long march around the enemy through the sun-scorched, waterless desert; after a few hours he brought them to a stream and invited them to drink, so as to observe how they would quench their thirst. Some of them rushed to the water like animals, laid down on their bellies and drank straight by mouth, which was considered to be indecent; others had enough character not to lower themselves down, and drank by using the hollow of their hands. Gideon selected them finally, three hundred men in total; all others he sent back. This was the selection of patience and endurance.

The calculations of Gideon were justified; his soldiers did not betray themselves; the unexpected attack was successful, and the enemies were smashed. But can the method of Gideon be considered to be generally infallible; and were mistakes eliminated from his method? Of course not. Obviously, Gideon did not have the time for a more precise investigation of his combatants; but it is doubtless that the representative basis of his selection was too narrow: he had to judge on the basis of only two *facts*, when the question was concerned with two constant, basic *features of character.* A single act may by virtue of an accidental combination of conditions express quite imprecisely the individuality of man. So, the trial of courage was imprecise just because there may have remained behind, among others, thoughtless and careless people who only vaguely perceived the danger of struggle, – and also those who were simply proud, and finally, those who did not want to go home because they were aware of some unpleasantness there. The trial of endurance suffered because the man who is patient in respect of thirst, may be unable to have the unremitting attention which is required in order not to betray himself, while creeping up to the enemy; and besides, here some people who ascribe too much significance to appearance and manners may also appear to be suitable. However, the task was such that if a single man out of the three hundred failed to live up to the situation, all would have been lost.

Therefore, where time and possibility are present, it is necessary to reduce the risk of errors by broadening the basis of selection: repeating, for example, a trial under different conditions, complementing it with new modes, etc. It is known that our former examinations in educational institutions were quite imprecise as methods of selection: students "failed" and were thereby doomed to various calamities just because of a simple timidity, an accidental headache, or even a momentary interruption of associative connections, the fatal coincidence of slipping to the student the only ticket which he had no time to review, etc. Just as unreliable, taken separately, are such criteria of the selection of workers in an establishment as certificates, personal recommendations, previous length of service, and visible intelligence, etc. It is necessary to have them checked systematically one against the other, i.e., a supplement and broadening of the basis of selection in order to minimize errors.

So, for example, the selection of courageous and resourceful people in dangerous situations is very important for the army. An officer, in order to carry out such a selection, creates during a march at night a false alarm, leading to a panic. If his soldiers have not yet been in battle, and the situation was new and unusual for them, then to evaluate and separate them according to the results of this first test would be a great mistake. Apart from the cowardly and easily lost, here are also people with great nervous sensitivity and a raised receptivity of the central-brain apparatus who are capable of inappropriate behaviour. But it is exactly such people who often possess a raised flexibility and plasticity of this apparatus; and in this case, when they get used to the conditions of military life, they represent a very valuable material in their resourcefulness, quick wits and ability to orient themselves. On the other hand, there are also possible purely accidental manifestations of weakness, depending, for example, on a temporary indisposition, etc. Much more reliable results can be expected after the second verifying test of panic, of course, in a sufficiently different situation.

The entire process of the diagnosis of illness by a doctor reduces to the application of a representative selection on a successively expanding basis. The symptom A is established; it is peculiar to the whole series of illnesses, and represents them all. But symptom B is related with it; it is also peculiar, perhaps, to many illnesses; but from the first series a definite part is not characterized by B, and can, therefore, be rejected; there remains a narrower circle. From this circle, symptom C permits rejection of still others, etc.,— until there remains only one type of illness, which has passed through all these acts of selection. In a similar way, the determination by a botanist of the discovered plant proceeds from one property to another, etc. It may happen that selection will remove all the known complexes of a given kind,— since representation is always based on prior experience, which is sometimes inadequate; then the doctor states a new illness unknown to him, the botanist a new species of plant; and the problem will consist in giving a precise representation to the complex which enters scientific experience for the first time. Fluctuating, unstable signs may be useful to representative selection in the same sense as is, for example, the sieve with heterogeneous openings, which in its various parts lets through different materials; in absence of anything better, it may sometimes be applied; in the case of flour, for example, a part of bran will also pass through and a certain quantity of litter,— but already relatively less than originally; so changeable signs may also help sometimes partially in the matter of diagnosis by "screening."

The development of knowledge must be directed to the working out of the most precise and strict representative characteristics; in this lies the meaning of all scientific classifications.

4. The Generalizing Role of Selection

Nature in its elementally-regulating work, as well as man in all of his activity, at first elemental and later conscious, has to deal at each step with masses of homogeneous complexes, more or less repeating each other, and varying only partially. For Darwinian natural selection, such mass-repeating objects are provided by propagation: it reproduces living beings according to definite patterns, with only relatively slight fluctuations and deviations. It is exactly such differences which determine the fate of forms; for example, of the insects of one species, those whose colour differs more from the colour of the surrounding environment are doomed to perish without posterity, and those, however, which approach in their colour closer to the environment and better blend with it, are preserved longer and are repeated with this peculiarity in posterity. Natural selection, as it were, generalizes given forms according to two categories— the unadapted and adapted,— just as God on the day of judgment, it was thought, must carry out a conscious generalization of the entire human material according to two categories, the righteous and the sinful.

Motor reactions of freely living cells, for example, of amoeba, present the first prototype of the "practice" of living organisms known to us. The elementally-generalizing tendency also appears here: to all that is "useful," i.e., conditioning the positive selection of the environmental complexes, the cell reacts by approaching it, to all that is "harmful," provoking in it a negative selection— by moving away. The matter is presented in such a form that processes of selection, which are provoked in the cell by an external influence, intensify one grouping of its activities, and weaken the other grouping,— thus their former equilibrium is disturbed, and there appears a movement of the cell, this or that reflex. If for some reason we cannot observe the cause of this reflex, seeing it we, can nevertheless, say *in general* that it is either a favourable influence to the cell, or, conversely, harmful to it. A nutritive substance, a local moderate rise in temperature and a ray of solar energy are generalized, for example, in the first category; a poisonous substance, a sharp rise in temperature and a contact of a solid body— in the second.

As the organism becomes more complicated, its reflexes, and later the reactions of a higher type developing in them,— "instinctive" and finally "arbitrary" reactions— also become more complex and at the same time more varied. But they preserve their *generalizing* character: the whole series of different, but in some respects homogeneous conditions of the environment engender in the organism selection, which is favourable to the appearance of one and the same reaction; in one series,— for example, a reaction of "flight," another of a "blow," the third— "a turning of the body to the right," etc. The reaction of a "blow" is provoked, for example, by an enemy, a prey, or a mechanical obstacle which must be removed in this way.

The same generalizing selection lies at the basis of cognition and thought, which originates in practice, and represents but a specialized group of reactions. Thus, a whole series of quite different sensations can be a reason for the utterance of the word "man," or to the appearance of this notion in the form of a "thought," or "concept"— precisely the same reaction, but only weakened and incomplete. This is called "generalization" in the ordinary sense of the term.

Human technology creates various mechanisms of selection; their model is the sieve frequently mentioned by us. Their action can be conceived as practically-generalizing; for example, the sieve lets through the most varied particles which are smaller in dimensions than a certain magnitude, and detains others, no less varied, which are generalized by the fact that they are greater than this magnitude.

Such is the generalizing role of selection. As we see, in human practice it is inseparably bound with "representation," namely, it constitutes the real basis of representation: what is generalized in a certain respect may be later represented by its common elements in any subsequent conscious selection. For example, Gideon could systematically select the courageous and the self-restrained soldiers only because an entire series of various facts of human life were previously generalized by verbal reactions— concepts such as "a courageous man," or "self-restrained man." People have always utilized the generalizing function of selection in the solution of their problems, but, as in other cases, they were tektologists without being aware of it and, therefore, did not do this consistently and expediently. Clear understanding here can also turn out to be useful and necessary in practice. I will cite some illustrations.

Here is the case which was communicated to me from the practice of our economy during the World War under Tsarism. There was a need to organize the production of thermometers which were previously received from Germany. The demand for them was tremendous, especially for medical purposes. In one of the provincial universities a workshop was set up for this purpose. The preparation of a glass globula with stretched out tubes did not present any difficulties,— we had a glass industry before. But the scientists-directors were nonplussed by the following problem: how to make the requisite scales with a division into degrees; the tubes were inevitably of different diameters, which caused mercury to rise differently; and to make a separate scale for each tube was unthinkable, since hundreds of thousands of tubes were needed. Fortunately, there was a German prisoner of war close at hand who solved this problem quite simply. How exactly? We had the solution already in many tektologically-similar cases; it was based on generalizing selection; but since this tektological experience was not consciously generalized, the sages would have probably thought much and independently arrived at what, in essence, has been known for a long time.

Clothing for an army is by no means sewn according to individual measurements. Experience has shown that in a given country out of a thousand men, drawn into the military service, so many on the average have such and such a height and size corresponding to such and such approximate measure, and so many to other measures, also definite, etc. Clothing is prepared beforehand according to these measures and proportions. And if a ready statistical generalization was not available, and clothing had to be sewn anew, facts concerning height and chest size could be collected during the admission of recruits into the army; using these facts tailors could at once cut the material for mass production. Evidently, it was exactly this situation which was present in our illustration, only with a substitution of glass tubes for people, and thermometric scale for clothing. The captive German suggested that ten thousand tubes be produced all at once and immersed in the water of a lower temperature, from which begins medical gradation, and then, having marked this level, immersed further in the water with the required higher temperature. It turned out that among two-three thousand tubes there was an adequately coinciding difference in levels, and that it was possible to make a common scale for them; for a thousand or more on one side of this level and for an equal number on the other, two additional sufficiently precise common scales could be prepared, etc., rejecting several hundred excessively deviating, not adequately generalizable tubes. This is the most usual correlation of generalizing and representative selection.

Similarly, an agitator appearing at a meeting sees before him the human specimen in mass variations, and must in the same way take generalizing measures of them in order to offer for their political souls a mass ideological costume which would be sufficiently suitable for them. The majority of beginning agitators do not understand this and pay by failures, which gradually lead them to the requisite methods. And here, a lot of extra expenditure of energy is wasted because the tektological homogeneous experience of different fields is not united, not generalized.

5. The Relationship Between Positive and Negative Selection

The basic correlation of the two kinds of progressive selection was already formulated by us as a definite contrast. Positive selection increases "quantitative stability" of forms, accumulating activities in them; at the same time it also increases complexity and heterogeneity of their structure, and thereby lowers their "structural stability." Negative selection decreases quantitative stability, successively removing activities, simplifies structure, changing it in the direction of homogeneity, and as a result increases structural stability.[1]

This contrast conditions the role of both sides of selection in universal development. It can be said that together they embrace the entire dynamics of this development. Positive selection by making forms more complex and increasing the variety of existence, supplies for it the ever growing quantity of material. Negative selection by simplifying this material, removing from it all that is volatile, discordant, antagonistic and introducing into its connections homogeneity and agreement, brings order and systematization to this material. Both these processes complement each other and spontaneously organize the universe.

The religious thought of the distant past, embodying the popular tektology of those times, provides one astonishingly beautiful symbol of universal dynamics. This is the Hindu Trimurti, or triad. Brahma, eternally creating, dreams, but he dreams real bodies, things and realities, as we dream images, dreams and thoughts. His slumberous, free and disorderly creative work piles up newer and newer forms: reality continually accumulates, complicates and differentiates itself,— this is done by positive selection. Siva eternally destroying, ruins all that is accessible to his destructive force, all that can be destroyed,— this is negative selection. Between them stands Vishnu preserving all that merits preservation, which is an expression of the results of universal dynamics at any given moment.

This naive tektology is quite clear and simple, free of doubts and contradictions. Scientific formulae in their breadth and precision always engender doubts and contradictions. And here before us arises a riddle; it can be formulated as follows. Positive and negative selection are mathematically opposite to each other; but mathematically opposite magnitudes, uniting mutually cancel each other; in what way then do positive and negative selection processes complement each other, and why do they not simply neutralize each

[1] I will remind you that both characteristics are valid within those limits, as long as we are concerned with "the same" form, i.e., so long as its basic structure is preserved,— until a crisis which changes it and to which, in their development, both types of selection inevitably lead. In other words, they are valid within the limits of the observed continuity.

other? With the equality of both magnitudes, forms must, apparently, remain unchanged rather than develop. Why in this case are plus and minus not reduced to zero, but give a tektological reality, a progressively-variable magnitude?

In the preceding we already encountered a number of times correlations which were no less paradoxical; – such is, for example, the characteristic of an organized and disorganized system, as a whole, which is practically greater or smaller than the sum of its parts. Mathematical correlations are but a special and, in addition, an *ideal* case of tektological correlations; therefore, mathematical thought does not fully embrace the actual tektological correlations, and often encounters contradictions in them. ***Mathematical equality of opposites is generally a tektological inequality.*** This is revealed everywhere.

In fact, any process proceeding in the direction of organization enlarges further organizational possibilities, while that proceeding in the direction of disorganization, on the contrary, decreases disorganizational possibilities. If the 100-million population of a given country, due to the excess of births over deaths, increases by 1 million in one year, then under the same conditions it will grow more in the following year– by 1,010,000, and in the year following that, by 1,020,000. If in another country there arose for the same 100 million an excess of mortality equal to the first, then in the second year, with other conditions being unchanged, the population will decrease not by a million, but by less– by 990 thousands, and in the third, by 980, 100, etc. One is the progression of increasing, the other of decreasing magnitudes. If one system, containing the organized sum of activities S, is destroyed, then this exhausts the question about it; it cannot be disorganized as such any further. If another system alongside the first, initially equal to it, developing gradually has organized in itself a sum of activities 2S, then quantitatively this only covers the loss of a given type of organization; but tektologically the matter does not end there, and a further process of development is quite possible. Thus, in practice progress is always greater than regress when their magnitude is the same; the organizational process is greater than the disorganizational one.

This point of view is already penetrating contemporary science. The proposed explanation by Van Goff of the universal Newtonian gravitation can serve as an example. The most common idea of the structure of matter, namely, that all atoms represent systems of equilibrium of positive and negative electrical elements, is the initial point of departure. According to the law of Coulomb, elements of the same name repulse each other, and those of different names attract each other; both actions are proportional to the magnitude of electrical charges, and conversely proportional to the square of the distance. It means that the attraction of a positive and a negative electron is equal, with other conditions being the same, to the repulsion between the two positive or two negative electrons; it is equal *mathematically*, i.e., it is expressed by one and the same numeric magnitude.

In reality the attraction manifests itself in that positive and negative electrons *draw together*, and with this, the attraction increases, since, in conformity with the law of Coulomb, the greater is the attraction, the lesser is the distance. Conversely, repulsing electrons *move away* from each other, and the repulsion itself *decreases*. Consequently, mathematically equal attraction and repulsion are practically, i.e., tektologically, not equal: the first is greater than the second.

Let there be two atoms of matter in which positive and negative elements of electricity are completely balanced. In this case, electrical attraction and the repulsion between them are equal quantitatively, but in fact they are not equal: attraction is greater than repulsion. It is this difference which produces the Newtonian "gravitation" between atoms. It can be presented so that elements of different names of both atoms draw together, and elements of the same name move apart inasmuch as the elasticity of the inner connections of the atom permits.[1]

Whether this theory will be adequate or not to explain the entire *present sum of facts*, its *logic*, at any rate, is irreproachable. Attraction is an elementary *organizational* tendency, directed at the formation of the simplest systems: electronic, atomic and mollecular ones; repulsion for such systems is a separating, *disorganizational* tendency. Under numeric equality, the first of them must be practically greater than the second.

I often had an occasion to apply the same logic to various questions of science. It permits, for example, to give a probable solution to the question of how the initial motor reactions in living organisms originated: the simplest "modulating" motions of the semiliquid cell, observed in amoeba. These motions, generally, are vitally-expedient: they *draw* the cell to the source of external influence which is *useful* to it, for example, to the nutritive material, and *remove* it from the source of a *harmful* influence, for example, a poisonous substance in the surrounding liquid— as if some elements of the environment were "pleasant" to the cell, and others "unpleasant."

We will proceed from elementary, hardly debatable physio-chemical considerations. The body of a cell is a quite complicated complex of protein and other mollecules in dynamic equilibrium with the environment. There are innumerable small influences on the part of the environment, and inside the cell continual chemical molecular, and physical changes go on. All this must engender in the body of the cell, especially in its peripheral

[1]Since the magnitude of the atom is exceedingly small, and this difference in the distances of its elements is, evidently, even smaller, the force of gravity, which depends on this difference, is quite negligible in comparison to he force of attraction or repulsion between the two electrons. The first is less than the second, approximately, by a billion decillions times (a quantity expressed by a unity with 42 zeros).

parts, continual movements, constantly changing their direction and character.[1] These movements remain largely unnoticed, because their direction at each point is constantly changing, and minimal opposite shifts are approximately balanced.

Now, let a substance poisonous to the cell, which is capable of dampening its functions, spread through diffusion from a definite point in the surrounding liquid. To the normal, small influences of the environment a new, more significant and besides, a directly harmful influence is joined. It will inevitably exert its force on the normal, minimal movements of the protoplasm. Being harmful and lowering the energy of the cell, it should, in general, weaken all of them; but only *not all of them to the same extent*. Movements which draw the cell to the source of a harmful influence should be weakened most: on the one hand, with these movements its action increases, and vital manifestations of the cell are suppressed more sharply— including, evidently, also these very movements; conversely, with shifts removing the cell from the harmful influence, all this takes place to a lesser extent; on the other hand, those parts of the cell which face the source of a harmful influence experience its action more strongly, and those, which are further away from it, experience a weaker influence; meanwhile the first constitute the initial point of attracting movements, the second— repulsing. Consequently, the movements of the first kind are generally repressed to a greater extent, of the second— to a lesser extent.

Thus, the former equilibrium of small shifts, especially in the frontier parts of the cell, is inevitably violated, and repulsing movements preponderate; slight differences of this kind, joining together, create the observed motion. This motion is expedient because it is the result of selection, and because it is directed at the re-establishment of equilibrium. The same considerations, in a reversed form, are applicable to the case of a useful influence, and the conclusion is quite analogous.

So the expediency of the primary reflexes of the cells is explained. But at the same time those cases where these reflexes turn out to be inexpedient also become clear. Such cases are much less frequent, but they are nevertheless encountered; and from our point of view they *must* be encountered. Selection creates the reaction of attraction under any influences which *directly* intensify the energy of vital functions of the cell; but such influences are not always, in the final analysis, useful for life. Other stimulating poisons may "attract" the cell, being harmful to it,— similarly to how alcohol frequently attracts man. In many microorganisms, light provokes a "positive" reaction, i.e., a movement towards the source of the rays; but under a strong chemical action of these rays, its consequences sometimes

[1]Especially in the peripheral, frontier parts because there the environmental influences have a direct impact, and because the magnitude of surface tension of the plasm alters in accordance with even the slightest chemical changes.

turn out to be destructive. Any "heliotropism" (movements toward the light or away from it), and "chemotropism" (movements toward a chemical influence or away from it) receive a simple explanation.

In physio-chemistry, there are many regularities of the "maximum" and "minimum" type, i.e., where phenomena tend to the greatest or the smallest possible magnitude under given conditions.

Why, for example, do liquids strive to assume a form which corresponds to the smallest surface under a given volume, the simplest illustration of which is the spherical form of water drops? Let us assume the presence of a quantity of liquid in the midst of innumerable, small and varied influences of the environment, no matter what they might be.[1] The form of a liquid, due to these or those influences, experiences innumerable small changes at various points of the surface. Some of these changes diminish the magnitude of the surface, others, on the contrary, enlarge it. But if both of them are equal on the average, then they are not equal in their results. Each contraction of the surface also diminishes the sum of external influences of the environment, for which this surface serves as the sphere of application; each enlargement of the surface increases this sum. Consequently, any time that the first occurs, there is a decrease in the energy of further changes, and this means that arises ***stability*** of the form; when the second occurs, the change is intensified and the stability is lowered. It is clear that from these innumerable, and for our senses infinitely small changes, the first should be retained to a greater extent than the second; reductions of surface should preponderate over surface enlargements. Adding up, all of them together produce then a minimal surface.

It is not easy to picture this process in all of its complexity and spontaneity. Many, for example, will retort that a liquid "at once" assumes the spherical shape of the drop, and that for the selection of minimal changes a "long time" is necessary. This objection, however, would be erroneous and naive, because its entire meaning reduces to uncritical use of the concept of time.

The expressions "at once" and "a long time" are not scientific, when applied to elemental nature: they assume a subjective measure of time which is given to us by the usual flow of our psychic processes. The same second, which in a labouring or cognitive activity is thought to be an extraordinarily short interval of time, because our consciousness is able to embrace during this interval only a small number of changes, is a vast period of time

[1]With this we should at first reject the concept of the "surface-tension" of liquids, which is only a conditional, typical expression of the results of interaction between the liquid and its environment.

from the point of view of molecular, atomic, and intra-atomic, etc., processes: in a second millions of millions of vibrations of particles of matter, etheric waves, etc. pass by; for example, for gamma rays the number of vibrations per second is determined, approximately, by the number 5 with 21 zeros (five sextillions); and each vibration is still a complex process, passing through numerous, or, more precisely and very likely, innumerable phases. The form of a liquid depends on movements which are not as small as that, but which are nevertheless molecular, for which trillionths parts of a second, for example, are large magnitudes. Of course, in order to detect the results of selection, time is needed, measured not by thousands of generations of organisms as in biological evolution, but by insignificantly small for us parts of a second.

But there are cases when phenomena of exactly the same character flow so slowly that months, years and even larger magnitudes may serve as a time scale for them,— this occurs when the same tendency to achieve a minimum surface is revealed in solid bodies. Such, for example, are stones at the bottom of a river or at a seashore. These bodies have very firm connections among particles; and influences of the flowing water and the solid particles carried by it, to which those bodies are subjected, can change their form comparatively slowly. But with the exception of this quantitative difference, all that was said about the selection of changes with a preponderance of those which diminish the surface of influence is fully applicable here; and the result is quite similar: pebbles are spherical, etc.; moreover, it is easy to trace all transitions from some irregular initial form of fragments to a minimum of surface.

The diffusion of light on the paths of the shortest time is also a result of innumerable processes of selection. According to theory, light waves go in *all* directions; but only on the paths of the shortest time are they subjected to positive selection, because they strengthen each other, and *negative* selection rules over all others. As has already been mentioned, two equal waves which merge crest to crest and valley to valley produce a *quadrupled* force of action; however, when the crest is merged with the valley, the waves mutually eliminate each other, — one of our examples of organization and disorganization. In all the wave paths, except in those corresponding to the shortest time, disorganization completely preponderates, and light phenomena are not present; on these comparatively few paths combinations of waves which create "light rays" are organized. Only they enter our perception, and only they are *considered* by us subsequently.

The evolution of life is also characterized by the creation of innumerable forms, of which only a minimal part is preserved, and others perish. The first enter into subsequent calculation of nature, the second are crossed off the register. Here the inequality between positive and negative selection appears most vividly: in the first there is always a possibility of continuance of selection; the second is continually interrupted by its own exhaustion. Quantitatively, the balance on its side is enormous— nevertheless the sum of organization increases. From the very beginning, when the concept of "natural selection" entered science, biologists noticed as its distinctive feature: ***economy in the final results, and a colossal wastefulness in the means of achievement***. The first expresses a rise in the level of organization, the second— the price of innumerable acts of disorganization by which organization is achieved.

From this flows the basic, universal *irreversibility* of processes in nature. Negative selection occurs everywhere; what it takes is irrevocably carried away; destroyed forms leave the economy of nature, and nature itself is now different than it was before, and all that is new is created under new conditions. When science speaks about phenomena which are reversible or repeating, then these characteristics are approximate and practical only; with sufficient investigation it is always possible to show their imprecision. The man who left his home cannot return home; because, even if he returns, it will not be the *same* man returning to the *same* home. Brahma does not dream twice about the same thing.

But this irreversibility has still another name: it is the *inexhaustibility of creation...*

VIII
Crises of Forms

1. General Notions of Crises

The Greek word "crisis" means "determination." Originally, it was almost exclusively applied in legal suits between two parties,— and then to the process of discussion in general; later, to the struggle of motives in the human psychics; finally, to any contest of opposing or competing forces. Moreover, under crisis a completion or a turning point of some process, which has a character of struggle is constantly understood: until a "crisis" the struggle goes on, the situation is indeterminate and fluctuating; the moment of crisis puts an end to this indeterminance and fluctuation— the victory of one party or reconciliation of both: something new begins which is organizationally different than before. If the court hands down a judgment, there is an end to the lawsuit, and what remains is the performance of a verdict; if the enemy is conquered, or if the two parties decide that to continue the fight is fruitless,— the war has no place, it is replaced by peacetalks.

Later, the notion of crisis broadened still further and was applied to any sharp transition, to any changes perceived by people as a disturbance of continuity. So it is customary to talk about the "crisis of illness " when the observed symptoms change sharply, the "crisis in the development of an organism," such as puberty or menopause (loss of the ability in women to bear children), when in the life of an organism new functions appear or former ones end. Social sciences denote by the same word not only moments of revolutions or deep reforms, but generally also periods of sharp social ills: crises of overproduction, high prices, the aggrevation of class struggle, etc. In sciences concerning inorganic nature such changes in the structure of bodies as melting, freezing, boiling are brought under this concept; "critical" (from the word "crisis" and not from the word "criticism"), for example, temperature of boiling is that temperature under which a liquid is inevitably, and independently from other conditions, converted into gas. In physics and chemistry there is a whole series of similar "critical magnitudes," i.e., magnitudes with which the unavoidability of a crisis is connected.

Tektology must with scientific precision establish its organizational, generalizing notion of "crisis." It was already outlined by us;[1] now we shall investigate it more closely.

Externally, the definition of a crisis is simple and obvious: *it is a change in the organizational form of a complex.* No matter how little is contained in this definition, an important characteristic of the notion "crisis" flows from it: the *relativity* of crisis. How is the notion about the "organizational form" of a complex established? Differently in different cases, more broadly or narrowly, in conformity with a given problem; and together with it our usage of the term "crisis" will also change.

The life of an organism can serve as an example. Let us assume that life interests us only from the most general biological point of view— as a struggle with the environment for survival, for a continual preservation of this complex; and, as we know, this preservation reduces to a dynamic equilibrium with the environment, to processes of assimilation-disassimilation. Then the entire life of an organism can be pictured as a single holistic series, containing within its limits, of course, many quantitative fluctuations of the dynamic equilibrium, now in the direction of greater assimilation, and then in the reverse direction,— it is connected with two crises only: conception and death, two boundaries of the series, the beginning and cessation of the vital process. But if in the organization of a living body we have to take into account also the most important of its particular functions which are the means of preserving life, such as breathing, digestion, motor reactions and propagation, then the notion of organizational form will be here much more complex, and we will find still further series of crises: birth, when, together with the environment, radically change the character and significance of motor reactions, when lung breathing and gastric-intestinal digestion begin; later the coming of puberty, when the ability of propagation appears; and sexual death, when this ability disappears. However, if we consider the organizational form in a more detailed way, investigating various concrete manifestations of the same functions,

[1]In the chapter on disorganization ("The Formulating Mechanism," Chapter 3)

then the number of vital functions will turn out to be great; for example, all transitions from vigilance to sleep and from sleep to vigilance will constitute crises: moments of interruption and re-establishment of a mass of psychic motor connections of the nervous mechanism; periodic and non-periodic changes in the condition of sexual apparatus; transition of individual muscles and glands from passiveness to activity and back, etc. Under even more detailed examination of the organizational form, at each of such changes the whole series of moments having a character of crises will be revealed again: physiological, physical and chemical transformations. In short, depending on whether the framework of our investigation includes the basic or more particular features of structure of the tektological whole, the same phenomena will be considered by us as ordinary phases which do not change their organizational form, or conversely, as its "crises." The notion of crisis is correlative with the "organization form" outlined by analysis.

All this already flows, as we can see, from the externally formal definition of crises, which, in essence, do not yet go beyond the limits of ordinary, prescientific cognition. But for tektology, as a science, it is insufficient to have a simple statement that crisis is a change in organizational form: there is a need for a general, fundamental explanation of such a change, a discovery of general conditions, a determination of its place and significance in the series of tektological processes. How can one approach the solution of these questions? This can be done most closely and simply from the point of mathematics.[1]

In mathematics,"magnitudes" are considered as increasing and decreasing; both are continuous processes which do not have a character of crises. But two of their moments represent real crises: they are the *origination* of magnitudes and their *destruction.*

Let there be a positive magnitude X. This, of course, is a symbol for some complex of practically-homogeneous activities. We can destroy this magnitude by adding to it an opposite magnitude, i.e., -X: a symbol for activities which are homogeneous with the first activities, but which are directed in the sense of a complete opposition to them. For example, if +X expresses a movement from a point occupied by us, in a straight line to the right of 1 kilometer, then -X will denote a movement to the left; they paralyze each other in a full disingression; this is their practical mutual-destruction, the symbol of which is "zero," a "zero point." Any other absolute destruction of activities cannot, of course, be admitted by tektology.

The other type of crisis is, as we stated, the origination of magnitudes: transition

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[1]Recall that we consider mathematics to be a part of tektology which had developed before its other parts, and namely, that part which has to do with neutral complexes (see **"Basic Concepts and Methods,"** Chapter on "Organization and Disorganiation").

from zero to an "infinitely small" magnitude. What is this "infinitely small" magnitude?

Assume that an astronomer was calculating the distance between the centers of the Earth and the Sun, and made an error of 1 kilometer. With contemporary methods this error cannot be captured experimentally, and for various conclusions which depend on the calculated magnitude this error has no bearing; the magnitude in the given case is infinitely small. It is, nevertheless, quite a real element of those same world distances: if we added to it a sufficient number of similar infinitely-small magnitudes, we would get a noticeable magnitude capable of changing the astronomer's conclusions; and progress in measurement methods may in the future make this "infinitely-small" magnitude also "finite," i.e., accessible to investigation and not lying within the limits of errors.

As we see, it is a difference between two magnitudes; it was arrived at by *subtraction* of the calculated magnitude from the real one. And subtraction corresponds practically to *disingression.* Here, of the two distances we must pass really or mentally, one in one direction, for example, from the Earth to the Sun, and then the other in the opposite direction— from the Sun to the Earth; as a result there will be a difference. The activities of transference are merged so as to achieve their mutual destruction. If this disingression is complete, then the result will be "zero," and there will not be any remainder; this would occur under an absolutely precise calculation. Let us assume that the calculation was absolutely precise; but after some time the real distance increased by 1 kilometer,— it does so change in fact; then our complete disingression becomes incomplete; it is partially violated, and the difference "appears" whose magnitude, although "infinitely-small," i.e., practically-insignificant and not taken into account, is present. This is the second type of a mathematical crisis.

Thus, both types are connected with the notion of zero, i.e., a *complete disingression* of magnitudes: in one case it *arises* in place of the former magnitude, in the other— it is *violated.*

We know the tektological role of a complete disingression: separation, or *severance of any organizational connections.* The violation of a complete disingression means, consequently, the *creation of organizational connections.*

Now we can return to a generally-tektological notion of crises. It was expressed thus far as a "change in organizational form." But what does this form represent? We know that it represents a *totality of connections among elements.* Consequently, a change in form can only consist either in a destruction of any former connections or in the appearance of new connections, or in both. But this means that the essence of crises lies in the *formation or violation of complete disingressions.* We have before us the same scheme which in a disguised form was given to us by mathematics.

Let us consider the conditions of some typical crises, for example, the melting of solid bodies. It depends, as we know, on temperature, which is an expression of the kinetic energy of particles of a body, their "living force," directed at separation, or severance of connections among them. These connections are supported, and with them the stability of the mutual location of particles, by activities of another kind which are denoted as "cohesion." In a solid body, cohesion preponderates over the thermal energy, and more than paralyzes its separating action. To heat up the body means to increase its thermal activities; with this, the preponderance of cohesion over it lessens; but so long as cohesion is still present, so long as it has not yet reached zero magnitude, the body remains solid; its molecules in their fluctuations maintain their former correlative location. If the process continues, then a moment arrives when opposite activities are balanced; thermal energy reaches the level which now disturbs cohesion; former stable connections are severed, and particles instead of fluctuating around one average position, begin to move in complex orbits. This mutual mobility of particles characterizes the transition from a solid to a liquid condition. A moment of crisis is the moment of formation of a complete disingression.[1]

Let there be an insulated conductor, for example, a metallic sphere, which is "charged" with electricity. The charge consists of special elements of electricity: homogeneous and mutually repelling elements. This mutual repulsion would have forced them to depart from the surface of the conductor and dissipate in space, if they did not meet resistances on the part of the non-conducting "dielectric" environment– the air, or glass. At some distance from the surface, very small for our measures, the pressure of electrical elements is fully balanced by the resistance of a non-conductor; it is there that a "boundary" for their diffusion is drawn; the stronger is their mutual pressure or "tension of electricity," the further from the surface is this boundary. Let us lay on this boundary another conductor.[2] At a corresponding point the resistance is thereby removed or, because of its smallness, becomes inadequate, and electrons would rush there, as water breaking through a dam, creating disturbances between the two conductors. If the second conductor is insulated in the same way as the first, then both of them together will form a single charged conductor; if, however, the second conductor is not insulated, i.e., connected with the ground by the conductor of practically, infinitely large dimensions, then both of them will be "discharged." Here the moment of crisis is the moment of severance of full disingressions.

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[1]In thermometers of Celsius and Reaumur this is expressed by the zero point. Of course, it is not the real zero temperature; we now know that the real zero temperature, i.e., the living force of the mutual motion of particles lies at 273° Centigrade below zero. But this is in fact the point of zero *difference* between two directions of molecular activities of water. Any complete disingression denotes some zero difference of a similar kind.

[2]More precisely not on the boundary, but sufficiently close to it, because in the second conductor is formed through "induction" (influence) from the first, an accumulation of the opposite elements of electricity, which also seek to leave the surface into the surrounding environment and are attracted by the electricity of the first conductor.

Particles of water and liquids move in complex, but *closed* orbits; in these orbits some of them are restrained by other, adjacent particles, and all of them generally by the pressure of atmosphere, the external activities counteracting their movements. So long as this pressure outweighs their kinetic energy, water remains as a liquid and only a small part of its particles, breaking lose from the surface, departs into the atmosphere, "evaporates"— those few particles whose speed of movements turned out to be sufficient to overcome the counter blows of the air molecules. With heating, i.e., increase in the kinetic energy of water particles, the number of such departing particles grows; but up to a definite limit the atmospheric pressure *in general* continues to outweigh this energy, and the mass of water remains calm. This limit for the ordinary atmospheric pressure is reached at 100° Centigrade. Then the stability of the system is lost and a mass-rush of water into the atmosphere starts— the *crisis of boiling.*

A great formal similarity exists between this case and revolutionary crises. The activities of rising classes are restrained, or repressed by the force of the ruling classes— so long as such a force is sufficient for this. But the growth of the former and degeneration of the latter into parasitism continually change the correlation: and the moment arrives when both magnitudes are balanced. Then the social whole loses its stability; and later there commences a breach of the lower strata through those limits within which the pressure of the upper strata held them.

The tektological designation of crises leads to them being discovered in many of those cases where everyday thought does not find them at all. So, let us assume that a body moves at first with an accelerated speed, then that this acceleration is lost, and later replaced by deceleration. At a point where the acceleration becomes equal to zero, there occurs, obviously, a complete disingression between the force giving rise to it and some other counteracting forces. To ordinary observation, nothing special has occured— the motion continues in the former direction. In fact, we have a crisis here— a deep change in the very character of motion. Mathematics expresses this change by that the "derivative of speed" being transformed here from a positive magnitude into zero, which, as we know, is the symbol for a crisis.

So in the life of an organism one of the most important crises corresponds to that elusive and hardly distinguishable moment, when its ascending line is replaced by a descending line: the preponderance of vital assimilation over disassimilation ends, in order to yield to their converse correlation.

From the point of view of ordinary thought, a crisis is a kind of *violation of continuity.* This would have been an insolvable riddle; tektology makes it solvable by substituting in the place of one continuity— two, with changing correlations. Such is the general method of solving all "arithmological" problems, i.e., problems connected with interruptions in complexes of experience.[1]

2. Types of Crises

We have already outlined two basic types of crises; they flow from our definition. Some crises arise from a violation of complete disingressions and, consequently, a break-up of tektological boundaries and, therefore, from the formation of new connections; others, on the contrary, from the formation of complete disingressions and the creation of new boundaries where they did not exist before, i.e., from the break-up of connections. The first type we will denote as "crises C," i.e., conjunctive or joining; the second as "crises D," i.e., "disjunctive" or separating. In essence, any conjunction begins with crisis C, the break-up of boundaries; and any disintegration of a complex originates from crisis D. It is easy to distinguish these two types abstractly, in thought; but when we begin to study phenomena concretely, as they are encountered in experience, it turns out that the problem is incomparably more complex exactly because simple crises do not exist: in fact, each crisis presents a chain of elementary crises of both types.

Let us take crisis C, the simplest in appearance; for example, a merging of two drops of water. We now know that even such an insignificant mechanical process does not occur without an expenditure of activities; without a destruction of some, even though an insignificant number of atoms, or at least without emanation of energy. But this loss of activities means tearing them off from the whole which is being created; and tearing off is crisis D, which presupposes the appearance of complete disingressions. And generally, a given crisis C, as any other crisis, is crowned, of course, with the creation of a new system with a new boundary; and this boundary can only arise through the appearance of new complete disingressions, where they did not exist before. Consequently, the closing moment for any crisis is D.

The division of a drop of water into two can serve as an example of a correspondingly simplest crisis D. And again, we know that disingression generally expresses only the negative result of conjunction. The drop could never divide "by itself;" this is a consequence either of its growth, for example at the expense of the atmosphere saturated with moisture, or intervention of still some other external force, breaking up connections among the parts of the drop. But both cases present nothing more than joining of activities from without; to do this, they must penetrate through the former boundary of the complex which pre-

[1] Dialectics— one of the embryos of tektology— has already outlined, in essence, the same method of solution, only in an insufficiently definite and insufficiently general form.

supposes the violation of full disingressions existing there. Consequently, moment D is necessarily preceded, as its condition, by the moment C.

As we see, the polar points of any crisis are the same in type: the initial point is always C, the final phase is always D. The scheme is the same: CD, implying, of course, under each of the two signs not a single elementary crisis, but the entire interlacing series of crises.

However, to limit oneself by this formal unity would be inexpedient. In the study of the concrete mechanism of crises we will have to divide them into groups, in which the central significance practically and the greatest interest theoretically falls on this or that side— C or D. This is well illustrated by the two examples given by us: we characterize them quite naturally, one as the typical crisis C, because it is exactly this moment which stands first in the plan of investigation of the question concerning merging of the water drops or other complexes, the second as the typical crisis D, since here the basic question concerns disintegration. And although we know that any crisis D is engendered by the preceding conjunctions, for the problem at hand in this or that case they may not have any significance, so that they can be assumed to be such or others, without the closest investigation.

Let there be a chemical reaction between sulphuric acid and chalk. Its beginning is simply a conjunction of these two substances; besides, in conformity with the contemporary views of theoretical chemistry, there must occur *all kinds* of combinations of their atoms— calcium, sulphur, oxygen, carbon and hydrogen; later there occurs an immediate disintegration of the majority of these combinations, as unstable; in this selection, stable combinations are formed and retained— water, carbon dioxide and sulphuric line;[1] they do not remain together but are divided by new boundaries: carbon dioxide goes up in the air as gas, and sulphuric lime forms a deposit (gypsum). Here, as we see, the final moment, D, is no less important than the first; and in order to give an idea about the crisis as a whole whole, we must characterize it from the start as a complex crisis, namely CD.

Radioactive substances, as we know, are in the process of a progressively proceeding decomposition, precise causes of which are unknown. From uranium tears off α -particle (an atom of helium with double positive charges), and as a result uranium X one appears; then tears off β -particle (an electron, or a pure negative charge), and as a result uranium X two appears; another particle falls off and before us is uranium II; again another particle, and we have an ion; a further particle, and we have radium, etc. It is clear that this crisis should

[1]The chemical formula is $H_2SO_4 + CaCO_3 = H_2O + CO_2 + CaSO_4$.

also be defined from the start as a complex crisis DD.[1] The same scheme should be used to express the crisis of a party, if it is found to be unadaptable to the social environment and breaks up into factions, which are then splintered into groups and which, in turn, disperse into human atoms.

The birth of a baby represents first of all its separation from the body of the mother: moment D. Then there is an entry into its organism of the whole series of new complexes-activities through breathing organs, movements and external senses: multiple C. Finally, a new relative equilibrium with the environment is established, on the basis of the determined tektological boundaries: again D. The characteristic of the crisis is, consequently: D.C.C.D. This is the case when we are not interested in precise explanations or when the explanations of conditions calling forth the act of birth are not given. If, however, they are considered, for example, when the birth occurred prematurely as a consequence of a mechanical influence or nervous shock, then the summarizing designation will be CDCCD. Of a similar kind, from a purely formal point of view, is the crisis of death: a break-up of some connections necessary for life; then, alongside with a further break-up of other connections of the organisms, there is also a violation of boundaries between its specialized tissues, and together with this also of general boundaries between the organism and its environment, from which destructive living and non-living agents are introduced into it; finally, decomposition into stable physical and chemical elements: DCD.

The union of hydrogen and oxygen was understood by the old chemists as a simple crisis C. For contemporary chemistry it presents quite a complex character: the splitting of particles of hydrogen (H_2) and oxygen (O_2) into atoms, formation of hydro-acids (HO), their groupings in pairs into hydrogen peroxide (H_2O_2), and its decomposition into water and oxygen; besides, it is likely that in the course of the entire process there is also a formation of still other, unstable, immediately decomposing combinations. In a similar way, division of a propagating cell into two, a simple act for the earliest observation, is now considered as quite a complex structural crisis, both from physical and chemical points of views. All depends on how far a given investigation penetrates.

In ordinary thought, the notion of crisis includes the speed or swiftness of change, of course, relative to the measures taken from everyday experience. For tektological analysis these measures do not have any significance. For example, thorium is a radioactive element, which is in the condition of decomposition— crisis D; besides, the average duration of life of its atoms is approximately 25 million years; the penultimate element from the products of this progressive decomposition, before the transition into a stable body, name-

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[1]Double DD is sufficient in order to express a series of processes of decay.

ly into lead, has an average life of approximately one hundred-trillionths part of a second; radium, however, has an average life of approximately 2,500 years, and all three of them need to be considered as being in the condition of a completely homogeneous crisis. Such is the generally-tektological point of view. The question is, of course, quite different when solutions to special practical or theoretical problems are concerned: each of them has its peculiar scale of precision; and if, for example, it is necessary to calculate the quantity of uranium or even radium in some combination in weight, then with contemporary methods of measurement there is no need to take into account the process of decomposition: there is no crisis in this problem. The notion of "crisis" is just as *relative* as are generally all the scientific notions.

3. A Limiting Equilibrium

Crisis is a disturbance of equilibrium, and at the same time a transition to some new equilibrium. The latter can be considered as a *limit to changes* which occur during a crisis, or as a *limit to its tendencies.* If we know the tendencies of a crisis and those conditions under which they unfold, then it is possible to predict the final result of a crisis— *that limiting equilibrium* to which it tends.

So, for example, if there are two connecting vessels with a different level of water in each of them, then crisis C proceeds between them, for which a limiting equilibrium is represented by the same level of water in both vessels. Or, let us assume, that a box lies on the table filled with accidentally thrown in pieces of uniform form – lumps of sugar, or unevenly spread flour, etc.; it is subjected to innumerable tiny tremours, coming from all sides through the wood of the table and the air: then, in the case of sugar, the limiting equilibrium will be that under which the common center of the weight of the lumps takes the lowest possible position; and for the flour that under which the upper surface of its layer turns out to be horizontal. The ancient truly Russian proverb,"by dint of patience one can come to be fond of a thing one disliked at first," expresses a limiting equilibrium of conjunctive process— a marriage between alien people in nature under conditions of insolubility of the conjugal union. If a young man experiences a crisis of ideological vacillations and doubts, then with sufficient knowledge of his former upbringing and a given situation, it is often possible to predict with great likelihood how the matter will end; for example, in the case of a religious man— in either a transition to or a repudiation of religion, or in a fresh reinforcement of religion. Thus, in the early 1920's, in my critical article in respect of the hesitations of Marxists of those days, in particular N. Berdiaev and S. Bulgakov, I was able to predict what they would come to: the first to a moderate liberalism with an aristocratic nuance, the second to clericalism with an agrarian colouring.[1] In other cases, a historian ob-

[1]See From the Psychology of Society, "Echos of the Past" (pp. 218-222, second edition).

serving an ongoing revolution, taking into account forces acting in it and its entire environment, can predict the form of organization of society that would emerge from it.

All conclusions and predictions relating to limiting equilibria assume, of course, a definite regularity ruling over the observed processes of the creation and transformation of forms. This quite simple regularity can be expressed thus: the more, in two distinct cases, the totality of elements and the environment in which they find themselves are similar the greater is the probability of similarity in the limiting equilibria to which the formulating and regulating processes (groupings and selection) tend in both cases.

In other words: the more homogeneous is the organizational material and conditions influencing this material, the greater similarities should be expected in the organizational products created from it.

However, this scheme, which appears to be self-evident, should not be oversimplified. It expresses an *organizational tendency*, which is always present, but which is not always embodied in the final result, because it can be emasculated or paralyzed by other tendencies flowing from the concrete complexity of conditions.

First of all, the following must be borne in mind. For the same aggregate of elements not one but several forms of a limiting equilibrium are frequently possible. Thus, there are substances having a *complete* identity of chemical structure, which are able to crystallize in various forms, or be now amorphous, and now crystalline; such are, for example, sulphur, phosphorus and carbon. Many chemical reactions culminate either in one or another combination. Of course, it does not follow from this that the "selection" of one or another limiting equilibrium is accidental; it depends on conditions under which transformation of forms occur; consequently, there is no contradiction with our scheme; but the difference in conditions often yields here with great difficulty to calculation and evaluation. This is especially true of living forms. The basis of biological species are, according to contemporary views, distinctions in chemical content in the living proteins: the mature organism of a species can be considered to be a form of a limiting equilibrium to some groups of proteins. However, many species are distinguished by so-called dimorphism, or even polymorphism, i.e., they have two or more, in our view many, diverging forms. For example, in some butterflies, the male and female and even polymorphic varieties of the same sex were considered by naturalists for a long time to be independent species. And among the lower non-vertebrates examples of such sharp divergence of the external signs of different sexes or alternating generations are encountered, which far surpass the average, usually observable distinctions among species. Besides, complex, indefinitely-changing conditions of the life of a species are usually considered to be approximately "the same" for its various individuals; and if under different conditions it is established that sexual dimorphism is connected with an absence or presence of such and such elements in the embryo, and a seasonal polymorphism, with such and such conditions of temperature and humidity, etc., then there still remains, with rare unexplained exceptions, the question why this polymorphism is being worked out here, and not in the neighbouring species; why is it sharper here, and, under apparently the same conditions, much weaker elsewhere, and, generally, what are its organizational mechanics?

At any rate, the number of possible limiting equilibria is always quite constrained; and, in essence, for each given case, there is even only one possibility— necessity; but our incomplete knowledge of conditions forces us to take into account and investigate various possibilities, from which only one is realized.

Of course, the very notion of a limiting equilibrium is relative, since finished forms and a halt to their development do not exist in nature. We call the structure of a mature organism a limiting equilibrium to which the development of an embryo tends, and this is quite logical inasmuch as the mature organism represents in fact the most stable form of life capable of reproduction again and again. But this does not preclude the fact that a mature form is the point of origin to processes of vital decline, and it tends itself, consequently, to a still more stable limiting equilibrium occurring as a result of death and decay— to the equilibrium of inorganic bodies. And this latter, moreover, generally competes with the first— masses of embryos and underdeveloped organisms perish, not going through the condition of maturity at all. Nevertheless, the condition of maturity is exactly what is important and interesting from the tektological point of view; only it has a positive organizational significance, determining the development of forms: what was destroyed before this phase, is simply excluded from consideration of vital evolution, it perishes, so to speak, in negative selection; what reaches this phase can reproduce itself again and again, as an object of positive selection and a point of origin of organizational processes, as a form which has been selected tektologically.

On the way to a limiting equilibrium regular interval forms, which can also be considered as relative limiting equilibria for a definite part of the studied process,are frequently observed. For example, a group of radioactive bodies, forming a family of uranium, is a successive series of chemical elements which result one from the other, existing for a longer or a shorter period of time— from tens of billions of years to small parts of a second: uranium I, uranium II, uranium X, ion and radium with its derivatives, right up to the final link in the chain, lead; it is considered to be a completely stable element, but, probably, alsobecause of our contemporary scales and methods observation. The larval forms of animals going through metamorphoses are also relatively-limiting equillbria; sometimes these forms have all the properties of mature animals, including the ability of propagation.

For chemical reactions, V. Oswald formulated the law of their sequence, according to which there appears in a change of combinations at first the least stable combination which is still possible under a given combination of reacting substances. For example, if a corrosive sublimate is treated with a chloride lead, their metallic mercury does not immediately appear, but calomel appears first. Calomel is unstable in the presence of chlorous lead and, after returning its chloride to chlorous lead, there appears mercury. With reactions of precipitation,a saturated solution appears first, and only later, at times quite later, a solid substance is isolated from it. If the existence of several solid forms is possible, a more soluble and a more changeable form appears first, etc. This regularity is important in the practice of chemical analysis, because it teaches the importance of biding one's time in order to obtain the precise results of a reaction. Tektologically, however, there is nothing more in it than an indication of the necessary interval forms; however, the instability of these forms reduces exactly to the fact that they are not final but transitional; the same calomel, for example, may appear as a stable limiting equilibrium in other reactions.

The notion of a limiting equilibrium will serve us as the basic instrument in the investigation of crises.

4. Crisis C

The initial point of crisis C is the break-up of a tektological boundary between some complexes. It leads directly to conjunctive processes which constitute the basic content of these crises.

Let there be two contiguous but yet tektologically separate complexes, A and B—two drops of water. These are molecular systems; the existence of a boundary between them at a point of contact indicates that there is a neutralization of oppositely directed molecular activities. Approximately, this can be pictured as follows. The most closely drawn together molecules of A and B are not yet bound by *coupling* activities (no matter what they are), not tied together exactly because there exist actions in the opposite direction, also coupling activities, which bind each such molecule with its own complex, as if drawing it back. So long as this action outbalances the coupling tendency between the two closest molecules of A and B, they cannot draw together to the average molecular distance which is present inside each of the two drops: contact in the precise meaning of the word does not yet exist. When the two actions are completely equal, i.e., form a complete disingression, then a contact occurs, but only momentarily, because we know that activities of two complexes external to the environment, not meeting here any resistance, capture the frontier line and create a partition.

However, thanks to the basic character of structure of both systems, this second case leads easily and even inevitably to the third. Molecules are in constant motion; the direction and magnitude of energy of this motion is continually changing for each molecule. Therefore, once "contacts" generally occur, even though they are momentary only, the disingression will be unstable if with the first approaches to molecular distance the tektological boundary is still maintained, then with one of the following approaches, in which the sum of molecular fluctuations in the direction of rapprochment turns out to be somewhat greater, this boundary will be violated; a coupling link will be established between the individual molecules which have drawn together. But since the former connection of each of these molecules with the adjacent frontier molecules was retained, the paths of fluctuations of the latter must now change, evidently, again in the direction of rapprochement of complexes; and, consequently, the boundary shortly after that will be violated for some molecules which were not previously in contact, but which approached it very closely. And these, in turn, will involve in still others a unifying process, etc. The merging proceeds in an avalanche-like fashion and embraces both systems, so that the boundary between them generally disappears: the basic moment of crisis C appears before us.

There occurs a merging of the organizational material: the two drops "diffuse" one into the other, and exchange molecules, the torn-off electrons and thermal energy. It is exactly this which constitutes the basic reconstruction. It is regulated by the processes of selection. The appearing groupings are in part preserved and in part disintegrated. Elements of the disintegrating groupings either remain within the framework of the same system, but now in other connections and correlations, or are removed from it entirely, passing on to the external environment. The loss of this kind of organizational material, as we know, always accompanies conjunction, only measures of this loss are quite different. In the given case, it is quite small and practically quite imperceptible. But it is present: mechanical motion of the liquid of the merging drops is inevitably bound with thermal energy, i.e., dissipation of certain quantity of kinetic energy, with the destruction of individual atoms when the freed electrons have a possibility to diasppear into the surrounding space, and with the discharge of radiant energy.

But this already enters the content of the culminating, necessary phase of the crisis: the establishment of new systemic boundaries and a new complete disingression in the place of the violated old boundaries. Removal of any part of activities exactly means the appearance of a complete disingression in the field of connections of this part with the rest of the complex. But apart from this, boundaries are generally restructured in a general reorganzation. Thus, strictly speaking, a "physical" boundary, which, as we know, constitutes only a part of tektological boundary, here too is not reduced to a remainder of the former physical boundaries of the two drops. Its transformation under the influence of selection gives the new drop a minimum surface in the form of an ellipsoid. In this ends phase D of the crisis.

Now we are going to change the conditions: let the merging drops consist not of pure water but of solutions of soda and hydrochloric acid in equivalent quantities. Then the process is complicated by a chemical conjunction with the whole series of reactions. According to the views of contemporary chemistry, here we have all kinds of groupings of ions on hand, into which both the dissolved substances and the solvent disintegrate. An enormous majority of connections which arise here decompose immediately as being unstable in the given environment. One of these connections, a combination of two hydrogen ions with a bivalent ion of soda CO_3, disintegrates into water and carbon dioxide, CO_2, which under normal temperature is gas, i.e., its particles possess such a significant energy of motion that it exceeds both the magnitude of their coupling among themselves and of the particles of the water solvent; they tear off, therefore, and are removed from the complex; only an insignificant part of them remains in a "dissolved" state, in molecular and atomic combinations with water. And water and the dissolved salt– sodium chloride– "survive" on the whole, forming the main content of the system.

Here phase D is expressed *quantitatively* much more sharply; a large part of the materials and complexes falls away, but the entire tektological character of the crisis is the same as in the first example. Not knowing precisely the structure of complexes and their environment, it is not possible to predict the extent to which crisis C will turn out to be the crisis of disintegration. Often, the process culminates in complete "destruction" of the merging complexes, according to the terminology of pre-scientific cognition. An example of this is the phenomenon of explosion.

Let there be a certain quantity of picric acid which is in a physical and chemical equilibrium with the environment. A complex particle of this substance consists of sharply oxidizing and restoring groupings; but they are sufficiently demarcated from each other to prevent direct merging. A strong thermal vibration from fire or a match, or a mechanical shock– a blow, or a flow of electrons from a discharging spark, or an explosive wave from priming, violates the external boundary of the system: new activities conjunctively burst into it. No matter how heterogeneous these influences are, the result is approximately the same: the initial, even though insignificant, regroupings lead at certain points to the break-up of internal boundaries between the restoring and oxidizing groupings of the same or adjacent molecules. New connections emerge, particles of which possess enormous kinetic energy previously "hidden" in the form of intra-molecular tensions. This "freed" energy bursts into the groupings of adjacent particles and engenders in them conjunctive processes leading again to the same connection of oxidizing with restoring groups, and a new "freeing" of energy, etc. The crisis develops in an *avalanche-like* fashion: the greater the number of molecules already embraced by it, the more will be embraced in the following moment. Thus the process continues until the whole chemical material of the complex is exhausted. The magnitude of kinetic energy of the transformed molecules far outweighs couplings among them; consequently, they scatter in various directions in the form of gases of high temperature under a great pressure.

There occurs "destruction" of the original form, i.e., everyday consciousness, being guided by customary means of perception, does not find this form at all in what has actually happened. To the scientific consciousness, the matter is, of course, quite different! There was preserved, only in a broken-up form passing into complexes of the surrounding environment, the entire structural material of the demolished system, and survived, with few exceptions, the chemical basis of its structure— atoms with their complex internal dynamics.

Tektological form is changeable, *but it is not destructable to the end*: with sufficient investigation we can always find remnants of the original organizational connections. Its complete destruction would be a destruction of the activities themselves which form it: having arrived at a complete disorganization these activities would have become inaccessible to experience, not producing any effects, not offering any resistance to the activities of our perception and labouring influence.

The impression of a "complete destruction" always depends on the limitation of our methods of perception. A being which "could see" atoms would have perceived the picture of the explosion quite differently, much more simply and holistically, without the apparent violation of continuity. For it, the whole matter would have been reduced to changing motions in molecular and intra-molecular groupings, shifts of atoms from one grouping to another, and a transition of closed orbits of most of them to open trajectories, with speeds of the former order: crisis, of course, is far from being as deep as it appears to our feelings. Such a being seeing atoms puts us on the point of view of scientific inquiry, the symbolism of scientific theory.

The three illustrations which we have just considered were taken from one field— physio-chemical processes. This was done in order to compare them easily from the point of view of the scheme of limiting equilibria. What is revealed by such a comparison?

In the first case— merging of the two water drops— the final result represents the greatest similarity with each of the organizing forms: it is also a drop of water, but only of a larger magnitude. In the second case, where drops consist of different water solutions, the result differs from them much more significantly: it is a drop of solution of the third substance, plus a certain quantity of dissipated gas. In the third, conjugating complexes are restoring and oxidizing groupings, in which the differences reach in many respects a chemical contrast; and the limiting-equilibrium, in the form of gases scattered in the atmosphere, differs still more sharply from the initial forms. No matter how approximate are the methods of comparison here, they are nevertheless sufficient in order to be convinced about the agreement of experimental data with our general formulation. And by selecting illustrations which yield more easily to comparison, we always come to analogous conclusions.

For example, with a biological merging of two cells of the same species, freely living or embryonic, the limiting equilibrium will differ much less from each of the initial complexes than with the merging of different cells, even though of close species, producing curs. The same can be said about the amalgamation of human organizations, common or different tribes, enterprises, political parties, about the merging of different dialects, religions, and about the synthesis of different scientific ideas, etc. It is easiest, perhaps, to trace the degree of similarity and differences in social human groupings as they are particularly close to us in our experience and, therefore, in a definite sense, particularly understandable, despite their complexity.

It is important to remember that it is necessary to take into account, in other cases, not only one but several limiting equilibria with small, for our contemporary methods, difference in conditions. So, for any vital complexes in their crises, besides particular highly organized biological equilibria, there are always, in addition, equilibria of "destruction," i.e., disintegration into simpler, "inorganic" combinations. We know, for example, that conjunction of infusorians raises their mortality, i.e., leads more frequently to the equilibria of "destruction" rather than a higher viability, though the significance of the latter preponderates in the history of the species as a whole.

The explosive type of crises represents special features which are essential to its understanding. The force of such crises, to a large extent, does not depend on the stimulus which is its direct cause; nevertheless, its energy must be "sufficient," and if it does not exceed a certain minimum, the explosion does not occur. Sometimes, however, the progress of a crisis, especially its tempo, changes considerably depending on the nature of a stimulus; for example, the burning down of pyroxylin in the air while lighting it up is incomparably calmer and slower than it is under the action of priming with detonating acid salts. How can the externally contradictory correlations be reconciled?

First of all it should be borne in mind that explosive combinations of any kind represent so-called *false equilibria*. We will remind you what this means. Those processes which proceed in the form of an explosion do not just begin with it: they were going on before the explosion, only so slowly that they were not caught by the usual means of observation. Thus a mixture of two volumes of hydrogen and one volume of oxygen, the detonating gas, from a spark "instantly" turns into water steam with an enormous output of heat; but water turns little by little into steam without a spark, under normal conditions: according to approximate calculations, with a temperature of 18° Centigrade, 230 billion years are needed for 60% of the mixture to be subjected to this conversion. Similarly, the society capable of a revolutionary explosion, which breaks through the internal boundaries of its groupings blending separated masses into a fighting avalanche, experiences long before the moment of the revolution, in scattered partial forms and weak degrees, processes of the same character: both conjunctions of revolutionary activities and their breach through the organizational limits of society.

With sufficient investigation, the same is also revealed for other "explosive" complexes. Consequently, the role of a trigger, which is directly responsible for the explosion, reduces to an acceleration of the tempo of the ongoing processes,— what in chemistry is expressed by the notion of "catalysts." [1]

Further, on what does the avalanche-like progress of explosive crises in fact depend? It depends on those activities which are "freed" by the crisis, i.e., from closed forms they pass into open forms, and themselves "free" similar activities in adjacent parts of the system. An "exploded" particle of picric acid explodes neighbouring particles; a "rebellious" member of a collective, which is under a social strain, for example, a starving or embittered mob, "incites others to rebellion," etc. When the activities, which are freed during a crisis, incomparably exceed the energy of the initial stimulus, there is observed what is called the independence of force and magnitude of a crisis from the provoking agent, provided, however, that the stimulus is "sufficient."

Let us consider the general conditions of this "sufficiency." In any explosive mixture, according to the received contemporary theoretical chemistry, there must occur from time to time explosions, at least of individual particles. The energy freed by this explosion either disperses before the next such explosion, which would have ensued for the same general reasons among the particles adjacent to the exploded one, or violates the equilibrium of some of them more or less deeply, or is able directly to explode others. Let us begin with the last case. Let one particle explode two such particles in this way; those, evidently, will explode immediately four more, which will be followed by eight more, etc. The crisis unfolds from the first stimulus, infinitely small from the chemical point of view. It is clear that such a complex cannot exist in practice. If, however, one particle does not directly explode others, but violates their equilibrium to the extent that this violation is not smoothed down before the next moment, which is called forth by the normal general conditions of a similar explosion, then after the second explosion there will be a considerable lowering of stability, and after the third—an even greater one, etc. The action accumulates and leads to a growth in the number of partial crises and a decrease in intervals between them. But then the remaining violation of equilibrium becomes even greater and accumulates even faster,

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[1]Substances, whose presence accelerates the progress of a reaction, sometimes to an enormous degree, not changing its general direction and final results.

etc. Obviously, this case differs from the former one in the magnitude of the coefficient of time only, and in general the existence of the complex is also not durable here, which practically may be considered as impossible.

There remains only the first of the three cases presented above; and it must be admitted that any explosive mixture, any false equilibrium in general, is characterized by such a progress of elementary crises that the residual energy of one succeeds to disperse to another, practically without a trace.

Let us assume now that a stronger agent than the normal influences acts on such a system, and that it explodes all at once, into 10, 100 or 1,000 elementary groupings. Then the situation changes. The freed activities spread to adjacent groupings and act on them either more or less in concert, or, perhaps, paralyze each other. The accumulation of the explosive action then occurs all at once: at some points a manifold piling up of activities is sufficient to call forth new explosions, and in others— to create an extreme instability, yielding to the slightest additional stimulus; and the first derivative explosions can serve as such a stimulus. It is clear that the crisis can unfold in an avalanche-like fashion only if the quantity of positive accumulations in question reaches a certain magnitude. And this is, obviously, more probable with 100 initial explosions than with 10, and with 1,000 than with 100. Where this quantity is reached there lies the minimum sufficient magnitude of the exploding agent.

Hence it is clear why the force and character of this agent may, in some cases, have a noticeable and even a great influence on the progress of a crisis. Many substances which burn fast and calmly when lit at one point sharply burst into flame from a wave engendered by priming, which instantly passes through their entire mass, or from a similar mechanically-percussive shock. Here is an illustration from another field. In a town or a country, the relationships of social forces have reached a high tension,— what is called a revolutionary situation. Then, for example, any isolated act of violence by representatives of one of the hostile parties with respect to persons belonging to another party, occurring in the presence of a few witnesses, arouses only agitation and indignation in those witnesses; while the fast-spreading news among the masses, verbal or by means of newspapers, about the same fact may serve as grounds for an uprising.

In contrast to the explosive type of crisis is the "fading" crisis. Simple illustrations of these crises are also provided by chemistry — namely, *reversible* reactions.

Let a union of one of the alcohols with acid proceed in a solution; the result of conjunction is ether of a corresponding structure and a particle of water; the formula is as follows:

alcohol + acid = ether + water

But as soon as some quantity of ether has been produced, it becomes by itself a means of conjugation with water, creating alcohol and acid in the reverse formula:

ether + water = alcohol + acid

Both parts of the process represent a typical crisis C with a culminating moment (division into two substances); but both processes go on side by side, and their speed is proportional to the quantity of the conjugating reagents: the more alcohol and acid we have on hand, the faster ether will be produced from them; but the more there is of ether, the more energetically proceeds the reverse conversion. At first, when the reaction began, it proceeded entirely in one direction— the creation of ether; but to the extent that its quantity appears and increases an opposite process arises and intensifies which, by adding up to the first, produces its visible deceleration. Thus the process goes on until both of them become equal and paralyze each other; in fact, an infinite time is required for the final conclusion of the process, but practically and approximately this is achieved in a limited period of time. Then we have a limiting equilibrium to which the crisis of the system tends. It belongs to the number of those which in physio-chemistry are called "true equilibria," and to which the principle of Le Chatelier formerly investigated by us is applicable.

All cases of the applicability of the principle of Le Chatelier can, in turn, be considered as crisis C of a "fading" type. Let us recall our former illustrations. Systems of equilibrium composed of water and ice under 0° are subjected to a raised pressure. This is nothing else than a break-up of tektological boundaries of given system, with a complex of mechanical activities of pressure formerly external to it entering and merging with it. And, subsequently, a reversible process of the conversion of ice under pressure into water, and water, when with a contraction of volume the pressure lessens, again into ice plays the same role as reversible chemical reaction in the previous example.

Let there be a tuning fork in the position of rest. It is brought into motion by a mechanical influence: from the general tektological point of view this is crisis C; new activities burst into the system from its environment, and the systemic "form" changes— the vibrating, sounding tuning fork is not the same as it was before. But the vibration gradually fades away: it is a "fading" type of crisis. The limiting equilibrium differs imperceptibly from the initial equilibrium: but, of course, it does differ; not a single vibration of the tuning fork passes without some trace on it.

Any body which receives a push and moves through a resisting environment gradually decelerates its movement and, finally, stops: this is analogous to the former case; it can be considered as a case of so-called "aperiodic oscillation."

As we see, the fading type of crises C is infinitely spread in nature; it embraces the entire universe of vibrations and arrested movements. If it turns out to be true that the universal process tends to a stable equilibrium through a continuous growth in entropy, then the entire life of the universe in our phase of it would also turn out to be one of the crises of this type.

Let us return to our first example— the formation of an ether complex from alcohol and acid. The fading progress of the crisis is based here on the two-sidedness and reversibility of reaction.[1] It, therefore, changes essentially if one of its two sides reduces to zero. Let us assume that the entire newly formed ether is removed from the field of reaction, or that water, with which ether again enters into a combination, is retained outside this field. In such a case the process is not stopped by the opposite conversion but proceeds to the end, until the total quantity of ether is produced out of the material on hand. This, however, is not an "avalanche-like" type of a crisis, since it does not contain self-acceleration. We shall call it a *middle* type. To it belong the majority of complete chemical reactions and also other conjunctions, similar to it in process.

So, let there be a connection between two vessels containing water in which the water level is different, and the bottom level the same in both vessels. Then the water will flow from the vessel with a higher level into the other vessel; but its *flow decelerates* as the level in the second vessel rises, because the water which had flowed into it presses in the opposite direction: this is a fading crisis. But if the bottom of the second vessel is considerably lower than the bottom of the first vessel, then the opposite pressure will not occur and the entire water may flow out: this is the middle type of a crisis.

Equally, in a clash of two armies— and we know that it is crisis C,— if one of them attacks and the other retreats defending itself, but maintains its vital and technical force, then the affair may proceed according to the fading type: retreating to its reserves, the other army strengthens opposition, while the active force of the first weakens through an expenditure of efforts on communications with the base and on protection of these communications; and a halt on a new front line occurs.

But if the attacking army is able to destroy parts of the enemy force so that their loss

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[1]It is easy to show mathematically that the same role is also performed by the reversibility of influences in our other examples.

cannot be compensated by moments favourable to the enemy, i.e., if opposition is eliminated from the field of military reaction, then the reaction may proceed according to the middle type of crisis; it may also assume an avalanche-like character, if internal collapse, revolts, and mutual destruction begin in the defeated army.

We see in these illustrations that different types of crises C may combine in reality, or replace one another. With the great complexity of phenomena it is not always easy to draw the boundary where one ends and another crises begins. Homogeneous tektological transformations are accomplished sometimes in one, sometimes in another, and sometimes in still another way.

The joining of hydrogen with oxygen under low temperatures proceeds according to the middle type, very slowly over billions of years; but for tektology this is immaterial: the resulting water does not decompose back, but leaves the field of reaction; in the gas element of Grove, the identical joining occurs in a short period of time, measured in hours. Under the action of a spark, the same reaction proceeds in an explosive way. If this occurs within a limited space, then the explosion is accompanied by high temperature under whose influence the water-steam begins to decompose back into oxygen and hydrogen; here, the crisis passes into a fading form and tends to the "true equilibrium" of both the gases and the water-steam.

Analogously, social revolutions proceed differently under different conditions. Revolutions burst out through an explosion, then having subsequently reached a maximum, opposite movements of social forces continue, and later subside and tend to a certain "limiting equilibrium." For England, however, the replacement of the feudal by the capitalist order, if taken as a whole, proceeded in the words of historians in an "organic way: " this was a series of fading crises; each of them tended to a definite equilibrium of old and new forms: it was maintained for some time, and, subsequently, the equilibrium was violated again due to the disappearance of a part of the old forms, i.e., their removal from the historical field of action, giving rise to a new crisis of the former type, etc. The fading form only predominated in these crises, but the explosive part appeared at the beginning, though less sharply than in the case of other countries; and during the Great English Revolution the explosive form even manifested itself as the basic crisis.

Generally, we perceive the flow of social crises as something especially complex; they contain varied combinations of avalanche-like and fading series. However, in the simplest crises of the inorganic world not only the practical connection, but also the internal kinship of these two types can be discovered quite easily: they are expressed by the same formulae of calculation— that is, a geometric progression or demonstrative function.

From the question about the progress of crises let us now go back to the question concerning their final result. Let the point at issue be an amalgamation of two social organizations: enterprises or parties, or entire countries, etc. These are almost always complexes of an egressive centralist type. What happens from amalgamation? According to the principle of limiting equilibria, the more homogeneous the two complexes are in their material and connections, the more it can be expected that the emerging system will be similar to them in its structure. Therefore, it is quite natural that, if they have one center each, the new system will also have a single center; and if they were characterized by a complex egression, then, generally, parts of organizational centers are removed so as not to have parallel competing centers; the preservation of all of them would have led, on the other hand, to disequilibrium. And this refers not only to egressive centers, but also to degressions which strengthen complexes: two orders, regulations, or legislations are replaced by a single one; inasmuch as this is not so, conditions are preserved for new violations of equilibrium.

As we see, the scheme of limiting equilibria here *requires* the removal from the system of those groupings which organize it egressively or degressively. This may also tektologically illuminate for us some facts from other fields of experience. For example, with fertilization, after the merging of male and female cells, half of the "chromosones," i.e., especially those yielding to the colouring of elements of nucleus, is rejected; and the doubled cell is brought to the structural form of the former single cells. According to the predominating opinion, this, among other things, lends a high degree of probability to the supposition concerning the special organizational role of the nucleus with its chromosones in the life of the cell,— namely the egressive role. It is surmised that the nucleus is the organizational center of the cell, and its chromosones are the carriers of the "hereditary properties" of the cell which determine its entire evolution.

The principle of limiting equilibria belongs to the number of those which have a universal significance for human practice. On this principle the productive and, generally, the entire labouring activity of people wholly rests: this activity proceeds from the *foreseen limiting equilibria*; in this consists its "expediency" or "regularity."

Human activities, as we know, are not essentially different from the activities of nature on which they are based; the organizational and disorganizational processes performed by man are not different from the processes of nature either in methods or regularities, and the activity of human labour is nothing more than an infinite chain of crises CD. His activities burst, so to speak, into the objects of nature and enter into an interaction with their elements; the predetermined limiting equilibrium, a new form— a product— results from the conjunction of an elemental complex with the complex of labouring efforts.

This is not just a simple comparison but a precise tektological description of facts. It is quite immaterial whether the contact of iron ore with fire, which smelts metal out of it, occurred accidentally, due to the action of elemental forces or as a result of the labouring activity of man: the latter is also included in the conjunctive series, just as elemental influences are included, and the final result is the same— a piece of metal. Man foresees the limiting equilibrium which corresponds to his need or desire, and introduces his efforts into conjunctive series so as to obtain the desired end: it is this which distinguishes expediency from spontaneity. But he foresees the desired end on the basis of his previous experience according to the same scheme which we pointed out: the more identical in various cases are the material and conditions under which his formulating processes occur, the more identical ought to be the limiting equilibria of these processes— their organizational products.

Man needs a definite product; and he knows from which complexes and under what influences such a product comes into being either accidentally or not accidentally, either in the elemental combinations of nature or in his previous labouring experience; leaning on this, man "applies his exertions" to the external objects, i.e., violates the tektological boundaries of objects, calling forth the desired series of crises C with the requisite culminating crises D.

It is necessary here to talk about a *series* of crises, because even the simplest acts of production do not reduce to a single crisis; and with its development, the process of production becomes ever more complex and embraces an increasingly longer chain of objects. In the newest mechanisms, the number of conjunctive links becomes enormous. For example, let the initial moment consist of pushing a button: the mechanical activity bursts into the system of a lock violating its equilibrium. As a result, the changed correlation of parts of this system leads to a closure of the current, i.e., the violation of boundaries of electrical complexes: electrical activities, entering the system of conductors and conjugating with their activities-resistances, change their magnetic condition; magnetic forces, in turn, engender mechanical crises: the motor is put in motion; through a great number of conjunctions of the transmitting apparatus, the motor overcomes resistances of the working instrument and material, etc., right up to the planned and calculated limiting equilibrium— a special form of the finished product. Each link of the transmitting series, when it receives a mechanical or other motion from other links, experiences, to a certain extent, an actual crisis in all of its structure— in the connections of its coupling links and tension, and in its thermal, electrical and magnetic condition, etc. This entire aggregate of crises C together with derivative crises D forms the structural aspect of production.

Not less, but often even more complex chains of crises CD constitute cognitive processes. The limiting equilibria of these processes are, however, foreseen much less frequently, and even if they are foreseen, then with much less certainty and precision than in the case of labouring practice. Consequently, it is necessary to admit, no matter how strange this sounds, that cognitive processes are in the contemporary phase of the evolution of mankind much less systematic, i.e., more elemental, than the practical-labouring processes.

And this is so in fact. The number of errors and failures, i.e., disorganizing combinations, is relatively much greater in the thinking of men than in production; only they cost less and do not constitute as great a waste of activities as do the errors and failures in labouring practice. Therefore, it pays mankind to transfer as frequently and completely as possible the spontaneity of search from the second field to the first. Long and complex series of cognitive combinations are verified *in reality* by a single and, sometimes, simple experiment; and if the limiting equilibrium in the experiment turns out to be different from the one which corresponds to the results of the cognitive series, then this entire series is rejected, but only at a price of a single practical failure, in place of many fruitless cognitive attempts. The systematic character of life as a whole grows in this way.

5. Crisis D

All crises begin with the phase C and end with the phase D. Therefore, if we single out a special group of crises D, we have in mind only the predominating significance of phase D. Consequently, we will concern ourselves with such crises only where they are of special interest and importance. Since it is exactly here that this phase can be best investigated, such cases will, in essence, constitute an investigation of the phase D in general, i.e., the regularities of phase D for any crises.

Let there be a homogeneous complex of stable structure; for example, a piece of hard metal. No matter by what influence— phase C does not concern us now,— let us assume that it is divided into two with the aid of an ideally sharp knife. We get two pieces of metal in the place of one: at first sight, this appears to end the crisis. In fact, this is not so: a series of structural changes begins only then.

In the place where the metal was cut, there appears a new "frontier layer" in each of the two pieces. The frontier layer finds itself now under completely different conditions and correspondingly acquires other properties than it had when it occupied an inner position. The process of this change forms the second stage of the crisis.

The new surface layer is being transformed in its molecular state, since the coupling acts now on it from one side only; it is being transformed both in its electrical state, since free electrons concentrate in it, and in its thermal state, since it becomes initial field of the heating or cooling of the entire piece; chemically, this layer becomes the field of reactions with the surrounding environment; mechanically, it begins to experience friction and direct jolts from this environment, etc. In general, we can sum up as follows: a new region of direct external influences on a given complex is being created, and a new sphere of the exchange of its activities with the external world arises.

Evidently, there must begin intensified processes of selection, in comparison with the former ones, which are directed at adaptation of the new frontier layer of the complex to its new conditions. Inasmuch as the environment of the complex as a whole remains unchanged, we can expect these processes to lead to a "convergence" of the new frontier part with the frontier parts we had before. For example, the brilliant smooth surface of the cut will grow dull, becoming similar to the remaining surface of the piece, as a consequence of the chemical influence of the atmosphere or mechanically damaging influences, etc. And, subsequently, structural changes will inevitably spread initially from the new frontier layer to the inner layer closest to it, then to the next, and there appears a scheme of "sequential selection" familiar to us. This is the third stage of transformation which must lead to a limiting equilibrium.

It is not difficult to predict the character of this equilibrium. With the homogeneity of metal, each of the resulting pieces is different from the original complex only in the quantity of organizational material, and must assume a correspondingly similar structural form to that of the original complex. A similar but not identical form, as we have seen above in the example of the water drop: there, in conformity to the law of minimum surface, each of the two resulting drops assumes the form of an ellipsoid similar to that of the original drop— but of an ellipsoid which is somewhat less flattened out. In the present example, processes of change and selection are incomparably slower, but their regularity, right up to the principle of minimum surface, is the same; and the quantitative difference in the sum of material also entails some minimal, "infinitely-small," i.e., practically unobservable differences between the final and the initial form.

The speed of achieving the limiting equilibrium depends on the *plasticity* of the complexes; the degree of similarity with the original form depends on the homogeneity of their organizational material. Both of these moments require special attention in crises D.

The homogeneity of material of the divided complexes does not exclude any of its complexity. So, with propagation of unicellular or multicellular organisms through division, and also through budding, the separating parts, which may be equal or unequal in magnitude, are sometimes biologically *mutually-homogeneous* in content, i.e., each contains an identical aggregate of the vitally necessary differentiated groupings. Therefore, the limiting equilibrium— the mature form— turns out to be identical with the former equilibrium; otherwise, this would not have been the *propagation* of a given form.

As an elucidating illustration can serve the artificial crisis D of the same kind; for example, the sectioning of living free cells. It turns out that in the case of a cell which has an isolated nucleus, the separated part continues to live and to adopt rapidly the previous form of the cell, but only if in addition to the protoplasm it also contains an appropriate part of the nucleus; however, if the nuclear tissue is absent, then life soon ceases and a complete disintegration ensues even with a large part of the protoplasm on hand. In the first case, evidently, we have artificial propagation: the separated part is sufficiently homogeneous in material with the former whole; in the second case such propagation is absent.

Many lower multicellular organisms possess a great ability to restore their form when sectioned into parts. Ciliary worms are especially distinguished by this: a segment in the form of a cut of one-tenth or fifteenth along the length of the body sometimes changes into a small worm. As should be expected, the restoration proceeds beginning with the region of the cut, since this is the initial point for new selection processes. The lacking organs form quite rapidly there, accordingly to the place of the cut, front in the front part, hind in the hind part, so that there appears, with a short segment, at first a very shortened form, which subsequently lengthens to normal proportions.

From the point of view of the scheme of limiting equilibria, it is evidently necessary to accept that the segment is to a high degree homogeneous in its material with the whole. It is exactly this thought which is expressed by biologists when speaking about the weakly-differentiated character of tissues and cells of ciliary worms: differing little from each other, the cells can group easily into various organs, in conformity the location and the function related to it.

Along with this, mobility and plasticity of elements have an enormous significance. What does occur in the area of the cut? The violation of systemic borders: the activities of external environment burst in where they did not have access formerly, engendering a series of partial crises C with a *destructive*, in general, tendency for the vital form. It is necessary to have reorganization and new stable frontiers with the environment before destruction proceeds too far. With a weak differentiation of the body, but lower plasticity, restoration of the form could turn out to be impossible, and instead of a biological limiting equilibrium there would be another—an inorganic equilibrium.

With the same ciliary worms there were experiments of complex, broken cuts, so that, for example, at the front or hind extremity there turned out to be two separate areas, one closer to the front, the other further to the back. As a result, abnormal forms appeared, with special head organs in place of each former front facet, or tail in place of each hind facet, etc. The conclusion from these experiments is that a definite "polarity" is peculiar to the body of the ciliary worm along the axis of its length; and the restoration of organs depends on the location of the surface of the cut relative to this axis. The cause of polarity is, apparently, the fact that the transference of substance and energy in a vital exchange has a definite direction. It is interesting, however, that with restoration of the form the role of the limiting equilibrium appears especially vividly, although such restoration is not at all vitally expedient.

Among higher animals, an analogous progress of crises is observed only partially in the form of so-called "regenerative" ability. This is a restoration of the lost parts of the body: a broken off tail in the case of a lizard, a cut off leg in the case of some tadpoles, and other less significant and complex organs; for example, parts of skin and epithelium in the case of the majority of the above-mentioned organisms. The regeneration is one-sided and quite limited here: the lizard restores its tail, the tadpole its paw, but the torn off tail or paw does not restore anything but simply disintegrates further; however, if more than a certain minimum is removed, then an incomplete regeneration is accomplished; for example, on the place of injury a protective layer is only reproduced; or even this does not happen, and the entire organism perishes.

In the world of plants, both full restoration and partial regeneration are spread more widely than in the animal kingdom: the differentiation of tissues is, in general, lesser; the plasticity, however, though even smaller, is relatively sufficient, because the tissues of plants are more vitally stable; they are not destroyed as quickly in the area of cuts and breakaways, so that restoring processes are often successful in achieving their aim. As far as crystals are concerned, their differentiation is, evidently, incomparably less, and each separate particle under certain conditions is able to reproduce the specific form of the whole.

Thus, the regenerating ability, in general, is more limited, the more systemic structure is differentiated. Propagation among higher organisms, apparently, stands in a sharp contradiction to this. One cell, having separated from the highly differentiated whole, consisting of millions, billions, or trillions of cells, fully "regenerates" the special form of the whole step by step. True, such a property belongs to one type of cells only, i.e., only to the ovum; even billions and trillions of other cells, separated from the whole, do not produce a similar restoration. How can this be reconciled?

The contradiction exists here only so long as we consider organized systems ***statically***, consider their forms as given at a particular moment, and in their pecularity. And as soon as we pass to the point of view of the tektological *development* of forms and their ***connections with the environment***, the problem appears in an entirely different light.

Was a human organism, for example, always from the very beginning of its life such a complex, dismembered whole as it is in the period of its propagation? No, at the moment of its conception it was a simple embryonic cell. Why and how did this cell become the whole organism? It was in a *favourable environment*, determining its growth and evolution: it was inside the mother's body, surrounded by the nourishing liquid and protected from any hostile influences of the external, elemental world. It easily assimilated new elements from this environment; the embryo grew at the expense of these elements, and its structure became more complex. Its various parts differentiated in conformity with the difference in conditions— the embryo's relation to this difference, connected with the position of its functions and changes in it with the progress of the environmental development. Thus, the mature organism finally resulted; it possesses a maximal sum of activities and their highest organization, but also finds itself in the most unfavourable environment, and now only maintains its equilibrium in this environment during a certain period, the period of maturity and propagation.

Now, a separated, new embryonic cell is before us, approximately the same as the former cell, and in approximately the same maximally favourable environment. The *tektological form is correlative* with its environment. Therefore, it is necessary to compare the given embryo not with the resulting mature form, which is already in another environment, another system of external relationships, but with that phase which existed in an identical environment for both the mature form and the embryo. It turns out then that the new, separated part is approximately homogeneous with its whole, taken in correlatively the same environment, the environment of the embryo. And it is natural that this part of its changes, parallel to the former changes of the environment, tends to the same limiting equilibrium— it reproduces a mature form.

In other words, the question about the final result of crisis D is resolved not by a static homogeneity of the separated parts with the former whole, but by a *dynamic* homogeneity correlative with the changing environment. In our first illustrations, the environment for separated complexes was not changing, and it remained approximately the same as it was for the former whole; therefore, environmental changes were not considered, and it was possible to compare directly the half of a drop, or a cell, or a cut worm with the original whole. Here, however, there are enormous environmental changes, and the comparison starts with the consideration of these changes. If the external heterogeneity is even quite great, but the difference between the separated part and the former whole, when comparing them historically, corresponds sufficiently to the difference in their environment, then the restoration of the form of the whole from this part is possible.

The same principle can also be traced in the development of social complexes. Let us take the following case. A widely branching out sect, a party or a scientific school is formed. A minimal particle separates from it, say, a small group, or even a separate individual, which does not agree with its doctrine. Can this particle "regenerate" the approximate form of the whole, i.e., develop into another sect, party, or school which would be tektologically comparable and commensurable with the first? A direct external comparison leads to the conclusion that this particle is structurally quite different from the highly differentiated whole. Therefore, if the environment is identical for them, then such a "regeneration" cannot be expected: the particle simply disappears and disintegrates in due course, when the heretics personally die. But under certain conditions, as we know, another result is also possible: the separated group or an individual gathers around himself, ideologically assimilating, newer and newer elements from the surrounding social environment, and together with them forms and develops a new organization. This organization, differentiating and securing itself with an ideological skeleton— a new unifying doctrine, gradually assumes a no less complex and finished structure than the structure of the former, so to speak, mother organization. From the "tektological-species" point of view, there occurs an approximate restoration of the systemic form. Of course, this is quite a different organization; it can be distinguished from the former organization in many respects— we know that children may be more or less significantly different from their parents; we are comparing forms in the organizational sense.

Why is all this possible? The principle of the correlation of the form with the environment gives a simple explanation of facts. In the epoch of its conception, the maternal organization was itself, in scale and structure, *approximately the same* small, socially undifferentiated complex, as the part separating from it is now: it was a separate individual or an insignificant group, with an embryonic ideology which was just being outlined in general. Why and how was this embryo transformed into an extensive, complex system? It was in a favourable environment conditioning its growth and development: it was inside the social complex containing numerous ideologically-unstable groupings, approaching the given embryo in material, and in many processes of ideological fermentation and search proceeding in the direction of its tendencies. From this environment, newer and newer elements joined the embryo and were assimilated by it, partly, of course, transforming it: the organization grew and elaborated. Branching out in the social environment, the embryo was subjected to a systemic divergence of parts in accordance with their position and function; its ideological skeleton-dogma, program, or doctrine, etc., was further crystallized. Thus, the process tended to a certain limiting equilibrium— to organizational maturity.

Its approach is also connected here with the fact that the environment was becoming less favourable. On the one hand, the sum of vital material for assimilation was being exhausted; for example, it was becoming more difficult to recruit neophytes for a sect, when almost all whose practical interests and modes of thought harmonized with its teachings had already joined it. On the other hand, the very ability of the organization to expand was being lowered as a result of decrease in plasticity; the degression consolidated, and the program or doctrine "ossified" to this or that extent and thereby conditioned the growing limitation of the form. Consequently, the tempo of development had to decelerate, right up to the phase of its greatest stability, i.e., the equilibrium with the environment preceding decline.

It is clear that if a separated part of the organization finds itself in a just as favourable social environment, it may become, in turn, an "embryo," the point of origin of the same development, which will also lead to an analogous limiting equilibrium. Of course, this happens very infrequently,and more rarely, than the opposite.

Thus, for example, in the history of European thought, Descartes happened to be the forefather of a great philosophical school, because in the social environment of his age there were many similar, related ideological groupings, which easily connected with his dualistic doctrine, and which were easily assimilated by it. But Spinoza, who emerged from this school and who was not inferior to Descartes in organizational strength and plasticity of thought, did not find such a favourable environment: in the diffused, unstable ideological groupings of the age there still prevailed a dualistic type of structure, and they were not assimilated by the much more monistic structure of Spinoza's teaching: therefore Spinoza remained alone *in his time*, and failed to form a philosophical school.

From the numerous heretics breaking away at different times from the catholic church and outlining dogmas of the protestant type, only Luther and Calvin were fated to become founders of new churches, comparable in scale with their maternal organization: an especially favourable social environment was necessary, which arose from the revolutionary development of commercial capitalism. Other embryos perished right at the start, or proceeded not further than a few initial stages of development.

Let us consider now some still important conditions for the restoration of form under crises D.

The primitive hunting commune, when it expanded so that it was already unable to maintain communication within the limits of too great a territory which was necessary for its subsistence, divided into two, similarly to the drop of water whose growing size breaks the coupling sustaining its mechanical connection. Each of the separated commune-daughters, if successful in remaining in approximately the former situation, settled down and lived as did the former commune-mother, with the same primitive division of labour and distribution of its products; and,subsequently, it grew to the same limit, beyond which, in its turn, it divided into two, as a freely propagating cell. Here all is simple and clear.

It is also easy to understand the principle which determined the basic line of division. We know that there was a natural differentiation with quite a sharp expression of complementary correlations: the physiological difference of sex and age, and the difference of function in the economy based on it. If the break-up of the commune followed exactly these complementary relationships, then the parts would have been heterogeneous in content in comparison with the former whole, similarly to the piece of a cell without nuclear tissue, and this means, they would be unable to restore the form. For example, if the male part of the commune separated from the female part, both would have perished; if adults and children separated, the latter would have perished.

In fact, similar correlations occurred sometimes forcibly in wars between communes, when adult males were destroyed by enemies, or when women and children were taken prisoners. However, under a natural division of the commune, a certain uniformity was realized by the mechanism of its collective work; viable complexes of people arose as a result.[1]

There are, however, cases when even the break-up along the line of complementary connections does not lead to a further destruction of the form, but passes into its relative restoration. Let us compare several cases of both kinds.

As we know, the primitive commune usually developed later into a "patriarchal," egressive type with authoritarian complementary relationships. When the head of the commune, the "patriarch," had died, this constituted a break off of the central link of egression. However, an immediate restoration occurs here: the deceased patriarch is replaced by a new one, and the life of the commune goes on as before. Why does this happen so easily? Because the patriarch was a unifying and not the single organizer of the commune. In its complex economy, embracing, usually, several hundreds of people, one man cannot guide directly all and all the time: under the patriarch's rule and control work several organizers from among the most experienced members of the commune, either older members or members who are distinguished by special abilities,— or, at any rate, there is an individual whom he prepares as his successor, and who substitutes for him whenever necessary. Thus, the commune, having lost a patriarch, organizationally corresponds not to the cell which is deprived of the entire nucleus, but to the cell which has lost but a part of the nucleus, though the most differentiated part. The distinction between the patriarch and his closest deputy is reduced to a greater or smaller breadth of organizational functions. For restoration it is necessary to have a degree of plasticity which enables organizational units to exchange their places within the system, and develop their functions on a corresponding scale; and such plasticity exists, and it manifests itself in the usual time.

A contrary case is described in the words of the Gospel: "strike the shepherd, and the flock of sheep will scatter." Here the central link cannot be restored, because the shepherd

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[1]With the propagation of cells a complex mechanism of karyokinesis was worked out, which serves, apparently, exactly in order that the heterogeneous elements of the whole be distributed as evenly as possible among the cell-daughters.

is considered to be the only organizer present.

A more complex case: a military group, say, a company, loses all of its commanding staff in a difficult situation, and is left to itself. Here two outcomes are possible: either an immediate restoration of the common command of the group, or a disintegration and destruction of the group. A company composed of peasants from some remote place, conservative people who are used to a stable environment and stable functions in it, in all of their upbringing, has a greater chance of perishing in a corrupting, formless panic than a company composed of city dwellers— workers who are used to changes in situations and relationships, and who also have a more or less significant organizational experience. For it is necessary that there be an individual who would be able and willing to assume the authoritarian function, and other individuals who would support him in this and assume directing functions of a lower order; and the rest must at once adapt to this change of roles, transferring to the new organizers the former disciplinary relationship; for all of this, it is necessary to have a corresponding composition of the group and corresponding degrees of plasticity.

There is a moment here which deserves special attention. In the company could survive, say, a sergeant major, who has received his skills over a long service, but because of inadequacy of knowledge and psychological flexibility is completely unable to direct the company in a critical situation; and next to him there could be an ordinary soldier who is fully suitable for the command by his experience and fast adaptability. The military organization has its own degression, in the form of regulations and discipline; according to the rules, the command must be transferred to the senior in rank, i.e., to the sergeant major, and in the given case the actual restoration of the organization would not have occurred. Then the outcome of the crisis will depend on the strength of the degressive system, its authoritarian ideology. If it has crystallized and ossified in the consciousness of the majority of company soldiers too firmly, they will not dare or, perhaps, dare too late, after a long hesitation, after new damages, to break the rules, to violate the "order," and the outcome will turn out to be a subsequent destruction of the whole.

Under less trying conditions a partial restoration may occur as a consequence of this conservatism of degression. As an example can serve some facts from the history of the Russian schism. The immovable authoritarian law of the old orthodoxy establishes that the grace of priesthood comes down from above, from the bishops, who alone have the power to transfer it to others. But the bishops had subordinated themselves everywhere to the state-church reform, and the diverging currents, sects of the "schism" found themselves deprived of a possibility to renew their priesthood. Some of them devoting an enormous expenditure of energy in various ways, acquired "lawful" priests, and attempted to acquire bishops; others simply repudiated priesthood and carried on without priests. In both cases a stable degression represented an important obstacle to a full regeneration of the form, in the second case even a decisive obstacle.

This significance of degression in crises D refers not only to social systems, but in general, and it flows, in essence, directly from its basic "skeletal" character. The significance of any "skeleton" is based exactly on its lesser flexibility and plasticity in comparison with the remaining parts of the system; thanks to this, the skeleton serves as a means of preservation, a means of strengthening the systemic form. We saw that ideology is more conservative than the human relationships which it organizationally forms; and thus, despite its entire seeming "ideality" and intangibility, ideology serves as their skeleton. The same is observed in biology: among the lower organisms, which generally easily restore their form under crises D, restoration is achieved with greater difficulty and less frequently, the more differentiated is their skeleton; and among higher organisms, with the loss of parts of the organism, those parts which contain isolated sections of the skeleton are also restored less frequently and with greater difficulty.

However, this rule has not an unconditional significance. Plasticity is relative: it may be greater for a given system or its skeleton in some respects, and lesser in others, greater under some influences and lesser under others. In ideologies, for example, plasticity is higher in the field of more particular concepts and norms, and lower in the field of more general, unifying ones; it is higher under insignificant, repeating influences, and lower under intensive but short-lived influences.

Examples of the latter present cases when sects or revolutionaries, firm in their convictions right up to becoming martyrs, are little by little, imperceptibly and completely transformed by the "engulfing environment." The former is easily illustrated by cases of disintegration into factions of such groupings as sects, parties and scientific schools. If, for example, a faction separates from the party as a consequence of a break-up due to particular provisions of the program, then this faction restores the systemic whole of its ideology comparatively easily and fast; if the break-up is deeply rooted, then a great and difficult ideologically-organizational work must be undertaken to make up the deficiency in all parts of the doctrine; moreover, instead of systemic regeneration, a further disintegration is possible. Such a result is the more probable, the faster and sharper was the original break-up.

Both outcomes of crises D— regeneration and destruction— do not represent an unconditional opposition to each other. The first is never complete and precise, but is always accompanied by a partial destruction, though at times a very small one. The second goes on only to a definite depth, and stops on these or other elements of the former whole, i.e., on partial complexes, whose damage is overcome in this or that way by a corresponding regeneration.

6. Universality of the Notion of Crises

We have already established that the notion of "crises" is relative and that its application depends on the limits within which the investigation of an organizational form is carried out. The fact of a "crisis" is acknowledged when as a result of the observed process there turns out a different organizational form than the one which had existed before the crisis. Thus, if in the structure of an organism the problem of our study is limited only to those basic features which remain invariable from its childhood to old age, then the entire life, all the development during this interval is considered as a single continuous process, and crises are *assumed to exist only at its two boundaries—at the beginning and at the end*; if into the investigation is brought any feature of structure which *appears or disappears between these limits, then its appearance or disappearance is treated as a special vital crisis.*

Let us carry this point of view sequentially to the end. Let a change occur in complex A, no matter what it is. We know that there cannot be in reality only a quantitative change and that positive and negative progressive selections are inseparable from structural changes. Consequently, the complex is tektologically different from what it was before; A became, to a certain extent, not A; but this means that there occurred a crisis of form. Thus, any change, when cognitive interest is concentrated exactly on it, on the difference between the form at the beginning and at the end, ought to be considered as a special crisis. Any "discontinuity" may be broken through analysis into an infinite chain of crises.

For example, the biologist usually considers the process of nutrition as being continuous in the organism. To the physiologist-chemist this is not so: the moments of crises are, for example, transformations of protein molecules of food,— its passage into a soluble state, its reaction with transforming gastric juices, its disintegration into amino-acids, the formation of new molecules of protein compounds from them corresponding to the structure of the organism, their entry into the structure of this or that cell, their new disintegration in the process of disassimilation... Equally, the oscillating processes of any kind, material and electro-magnetic, may be thought of as continuities: but in the analysis of waves each of the innumerable *phases*, into which the progress of a wave can be broken, may be taken tektologically, as a special form, since it differs from the preceding and the following wave in correlations of velocity, acceleration, etc.

We see that for tektology the notion of crisis is *universal.* This is simply a special point of view applicable to everything that occurs in our experience; for only changes occur, and any change can be considered from the point of view of the difference in form between its initial and final point.

For us, of course, it is immaterial that this contradicts the usual notion of crises. But is there also a contradiction with the general scientific concept, according to which a crisis is the result of violation or formation of complete disingressions? There is no such contradiction.

In fact, if there is a change in the tektological form of a complex, then its essence lies in either new activities entering the complex or a part of the former activities being removed from it or regrouped differently, generally speaking, the first, second and third may happen simultaneously, but only in different degrees. The first means a violation of old external boundaries of the complex; the second— the creation of new boundaries; and the third— a shift in its internal boundaries among the constituent groupings, its parts, i.e., again break-ups and the formation of boundaries between them. All this corresponds to the scientific understanding of crises.

From the universality of the concept still another important consequence arises, a conclusion about crises of different "degrees" or "orders." Let us, for example, have a detonating mixture of oxygen and hydrogen under a high temperature; their slowly proceeding union into water is a crisis of a definite type, namely, that of the "middle" type. Under the influence, let us assume, of a spark, the progress of the crisis changes radically and assumes the avalanche-like form of an "explosion." The former crisis continues, but in a new way; and we have full grounds to say that there occurred a crisis in its flow; this is already a "crisis of a crisis." Subsequently, when the explosion raises temperature of the mixture to the height under which particles of water begin to decompose back, the progress of the process becomes "fading," i.e., different again. Such changes are "crises of the second order."

In the progress of any revolution it is possible to capture similar "turning-points" where the tempo, direction and correlation of organizing processes creating a revolution change,— these are also secondary crises.

Evidently, the progress of crises of the second order may, in turn, contain crises of the third order etc. We shall elucidate this by a simple analytical example. Very often, if not the entire crisis, then its separate features can be measured quantitatively; they can be expressed in the system of coordinates by curves. Those points where a curve sharply changes its direction, for example, where it turns on an angle, or changes its properties expressed by an equation, will correspond to secondary crises.

Thus, let us have a body which moves from A to B, at first with a growing acceleration, then with a diminished acceleration, then with deceleration passing, finally, to a halt. This entire crisis can be considered as the crisis of location in space, changing spatial relationship of the body to its environment, – a crisis of the first order; it can be expressed by the line of motion of the body. Its progress is characterized by velocity; it is, speaking mathematically, the first derivative of space to time. If we express it by a curve, then a turning point where the velocity ceases to grow, in order to pass to a decrease will be revealed on it; there, the acceleration becomes equal to zero; and this, of course, is a crisis, but already of the second order; mathematically, it is "the second derivative," i.e., acceleration passes there through a zero point. If this acceleration is expressed by a curve then there will also be a turning point on it: in its first part, where positive acceleration ceases to grow in order to pass then to a progressive decrease in the second part— where in a similar way negative acceleration ceases to grow (i.e., "deceleration"). In both cases an "acceleration of acceleration" passes through zero, or the third derivative: this is a crisis of the third order. Evidently, complicating the example, it is easy to represent also crises of the fourth order, etc.

Mathematics reveals that crises of motion, crises of velocities, accelerations, etc.,may ideally continue without end, as can continue the chain of derivatives. But practically, the investigation going beyond crises of the second order has to be carried out infrequently. In part this also depends, probably, on the fact that crises of higher orders cannot be captured by the usual methods of perception, but are discovered by scientific calculation or juxtaposition.

The theory of systemic crises once again vividly illustrates the character and tendency of tektological investigation. It originates from a broad generalization, prompted by living experience; such is in the given case the usual notion of crises. This generalization is scientifically elaborated; and when it assumes the form of a precise scheme, then it becomes not just broad, but a universal generalization. A special point of view is revealed at its basis, one which may then be applied without limit to the most varied fields of organizational experience, elucidating the path to the solution of the most varied practical and theoretical problems. This is an abbreviated repetition of history of the development of organizational methods of mankind.