

# **BOGDANOV'S TEKTOLOGY**

## **Book 1**

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Robert L. Flood

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## Foreword

### **ALEXANDER ALEXANDROVICH BOGDANOV AND "TEKTOLOGY"**<sup>1</sup>

Alexander Alexandrovich Bogdanov was a prominent Russian philosopher, scientist and political activist the end of the XIX century — and the first quarter of the XX. Amongst his numerous scientific achievements, and philosophical conceptions "Tektology", the universal organizational science, is undoubtedly the most significant contribution by Bogdanov to world culture. Not without reason. In Tektology he criticized the philosophical ideas which he propounded at the end of the XIX century and even at the beginning of the XX — including empiriomonism, his main philosophical conception. Bogdanov, until the end of his days, constantly emphasized the radical novelty and universal value of tektology.

The name "Bogdanov" was the pseudonym, or, more precisely, one of many, together with "Maximov", "Riadvoy", "Werner", of Alexander Alexandrovich Malinovsky. The pseudonym "Bogdanov" was used by Malinovsky most often, and under this name he was to go down into the history of Russian and world culture.

Alexander A. Malinovsky was born on 10th (22nd New Style) August 1873 in the town Sokolka of the province of Grodno<sup>2</sup> into the family of a school teacher. He attended the gymnasium (high school) in Tula, and after graduating with a gold medal, entered, in 1893, the Department of Natural Sciences of Moscow University. However, he did not study there long. In December 1894 Bogdanov was expelled

from the University on account of his participation in the work of revolutionary students' groups which were under the influence of the ideas of *narodism*<sup>3</sup>. Arrested and exiled to the town of Tula, he immediately became involved in revolutionary activities, and soon began to share social democratic views. From 1896 Bogdanov was a member of the Russian social-democratic labour party (RSDLP). As a result of Bogdanov's activity, together with other revolutionaries, the social democratic organization was established in Tula in 1897.

At the same time Bogdanov's literary and scientific activities began. In 1897 he published "A Short Course of Economic Science"<sup>4</sup> which became, in the pre-revolutionary years, one of the basic textbooks for the study of Marxian economic theory by workers' groups, and went into six editions before 1905<sup>5</sup>. In 1899 Bogdanov graduated from the Medical department of Kharkov University. In the same year he published his first extensive philosophical work "Principal Elements of the Historical View of Nature"<sup>6</sup> and two years later the second — "Knowledge from the Historical Viewpoint"<sup>7</sup>.

The last years of the XIX century and the first decade of the XX century was the time of Bogdanov's most intensive revolutionary activity and simultaneously the peak of his creative work in science and philosophy.

A short time after graduating from University Bogdanov was arrested for actively promoting social-democratic propaganda, he spent half a year in Moscow prison, and, as a politically unreliable person, was then exiled; first to the town of Kaluga and then for three years to the town of Vologda. In the spring of 1904, when his exile was over, he went to Switzerland where he took an active part in the struggle among the leaders of the Russian social democratic movement; i.e. between the *mensheviks*, headed by G.Plekhanov and the *bolsheviks*, headed by V. Lenin<sup>8</sup>. Decisively, Bogdanov sided

with the *bolsheviks* and together with them, laid the foundations for the III RSDLP Congress, in particular, he went to Russia to enlist bolsheviks from the Russian provinces to take part in the Congress. At the III Congress of the RSDLP (London, April 1905) Bogdanov read several papers and was elected to the higher body of the RSDLP — the Central Committee, to which he was re-elected at the IV (1906) and V (1907) RSDLP Congresses.

Bogdanov took an active part in the First Russian revolution in 1905, he was a member of the Executive committee of the Petersburg Soviet of Labour Deputies. After the defeat of the revolution he was arrested. On release from prison he reverted again to revolutionary activity, and in 1907 went abroad where he, together with V.I.Lenin and I.F.Dubrovinsky, formed the team which edited the central organ of the bolshevik press "Proletarian". During that time a bitter argument between Bogdanov and Lenin flared up — first, on issues of the tactics of the Russian social democrats in relation to the defeat of the First Russian revolution, and then — and here the positions of the disputing parties were irreconcilable — on the problems of treating the essence and paths of the development of Marxian philosophy. Lenin gained victory over Bogdanov in this debate, in any case he was supported by the other influential figures of Russian social democracy. As a result, in July 1909 Bogdanov was taken off the editorial board of "Proletarian" and Bolsheviki's Centre, and in January 1910 at the Plenary session of the Central Committee of RSDLP he was expelled from the Central Committee of the party.

In 1909 Bogdanov together with those who had a similar way of thinking, including the well-known writer A.M.Gorky, the influential member of RSDLP and literary man A.V.Lunacharsky, and others, organized the "High Social-Democratic School" on Capri (Italy), and later the group "Vpered" ("Forward") separated from Lenin's

"Proletarian", pursuing aims of the cultural education of the proletariat on the basis of Bogdanov's idea of "proletarian culture". Neither of these enterprises found success: at the Capri school there were constant political debates and eventually the majority of workers-revolutionaries there went to join Lenin in Paris; "Vpered", under influence of one of its members — G.Alexinsky — started an open campaign against the Central Committee of the RSDLP, and Bogdanov was forced to leave, moreover, he withdrew completely from practical political activity and entirely concentrated upon realization of his creative — scientific and philosophical — plans.

Philosophical discussions in 1907-1910 among the leaders of Russian social-democratic labour party of the time not only greatly influenced the personal fate of Bogdanov but also to a great extent pre-determined the history of Russian social democracy as a whole. The leading figures in those discussions were, the leader of the mensheviks — G.V. Plekhanov and the leader of the bolsheviks — V.I. Lenin on one side, and A.A. Bogdanov — who played an important role in the bolshevik fraction of the RSDLP on the other. The partnership between Plekhanov and Lenin, in those discussions, was not organic enough — their political and tactical differences were too strong, Lenin never missed an opportunity to make comments on the philosophical "mistakes" and "inaccuracies" of Plekhanov, nevertheless both of them were resolute in "unmasking" the subjective-idealistic foundation of the conception of empiriomonism introduced by Bogdanov.

The main ground for their attacks was Bogdanov's work "Empiriomonism", three volumes of which were published in 1904-1906<sup>9</sup>. While the first of Bogdanov's serious philosophical works mostly surveyed the problems of the philosophy of science at the beginning of the XX century in "Empiriomonism" he disclosed his own understanding of philosophy and proposed an original



philosophical conception. Certainly, Bogdanov's intellectual evolution did not stop with empiriomonism but later he concentrated mainly on the scientific sphere proper, primarily in the framework of his universal organizational science — tektology, however the highest point of his studies in the domain of philosophy was undoubtedly empiriomonism.

Bogdanov himself was greatly inspired by empiriomonistic ideas and in the second part of the first decade of the XX century he published a whole series of papers disclosing the principles of empiriomonism including a challenge to Plekhanov to speak out openly on questionable philosophical matters<sup>10</sup>. The reaction on the part of the leaders of Russian social democracy was not long in coming: in 1908-1910 Plekhanov had answered "An Open Letter to Comrade Plekhanov" (1907)<sup>11</sup> in three verbose letters to Bogdanov under the title "Materialismus Militans" with the sub-title "A Reply to Mr. Bogdanov"<sup>12</sup>, and Lenin published, in 1909, his book "Materialism and Empiriocriticism"<sup>13</sup> in which Bogdanov played the role of one of the main "characters". Bogdanov's answer to this criticism was published in 1910<sup>14</sup>, and was practically the end of the discussion for that time. Later, from the 1920s to the 1970s, official Soviet philosophy, ideologized to the core, had worked out a standard interpretation of that discussion, to which it strictly adhered: Bogdanov made an attempt to pull the subjective idealism of E. Mach and R. Avenarius into Marxian philosophy; Lenin together with Plekhanov gave Bogdanov a fight and unmasked him as a subjective idealist who had eventually been caught in the snare of solipsism and who advocated fideism and popovshchina (religious superstition)<sup>15</sup>; therewith Lenin's "brilliant" work — "the great creation of militant materialism" — undoubtedly greatly surpasses in its importance the critical letters by Plekhanov who himself fell into philosophical error from time to time.

Certainly, this official Soviet interpretation of the philosophical discussion of 1907-1910 was far from the actual situation. As a matter of fact two attitudes toward the understanding of the philosophy of Marxism clashed in those arguments. One of them was that of Plekhanov and Lenin, and the other Bogdanov's. The first can be characterized as *dogmatic*; it moves not one iota from the philosophical formulations of F. Engels in his works "Anti-Duhring" (1877-1878) and "Ludwig Feuerbach and the End of Classical German Philosophy" (1886), the second — as creative, aspiring to combine Marxian philosophy with the latest tendencies in the development of science and philosophy.

Plekhanov and Lenin were of the opinion that Bogdanov had abandoned, or at least he was in the process of abandoning, the ground of Marxian philosophy. It was a very deep delusion. Bogdanov, in spite of the radical evolution of his philosophical views, was a *convinced Marxist in philosophy* to the end of his life. He stated it boldly in all his philosophical works, from the earlier ones which appeared at the turn of the century, including "Empiriomonism" (1904-1906), to the later "Philosophy of Living Experience" (first edition — 1913, third edition -1923)<sup>16</sup> and others. However, he did not pay so much regard to the philosophical utterances of Engels represented in "Anti-Duhring" and "Ludwig Feuerbach and the End of Classical German Philosophy", as to the "socio-philosophical theory of Marx, i.e. the idea, that the development of society depends on its economic life"<sup>17</sup>.

Notably, the most frequently referred to of Marx's work in Bogdanov's papers was his "Theses on Feuerbach": it was this work, where Bogdanov found the essence of Marxist philosophy. (in doing this, he paved the way for studies of the "young Marx", which has become a popular engagement of Marxists in the fifties and sixties). Remarkably, Lenin cited these famous "Theses" of Marx only

sporadically. Bogdanov called Marxist philosophy the "social materialism of Marx", and much less frequently — the "historical materialism of Marx", accentuating the *social dimension* of this philosophical doctrine.

What does that mean? Let us leave this to Bogdanov himself: for him social materialism strives "*to understand its knowledge*, to explain its world-view, and, in accordance with Marxist ideas, this can and must be done on the basis of socio-genetic research. Evidently, the principal concepts of the old materialism — 'matter' and 'unchangeable laws' — had been developed in the course of *social* progress — and, like any ideological form, they should have their "material basis". But as the "material basis" tends to be changed in the course of social development, it is clear that any given ideological forms have only historical and transient, rather than objective and superhistorical significance. It can be only a 'that-time-truth' (the *objective* truth of a certain period) — and by no means an 'eternal truth' ('objective' in the absolute meaning of the word)"<sup>18</sup>. Therefore, claims Bogdanov, "Marxism implies the rejection of the unconditional objectivity of any truth, the rejection of all absolute truths"<sup>19</sup>.

What has just been cited must be sufficient to contrast Bogdanov's interpretation of Marxist philosophy both with Engels's "classic" interpretation of this philosophical doctrine and especially Plekhanov's version of Marxism, which, to put it in Bogdanov's words, tried "to justify Marx by references to Holbach"<sup>20</sup>, and was essentially *dogmatic*. Engels's interpretation of the so called "principal philosophical problem" Bogdanov claimed to be "a survival of authoritarian dualism"<sup>21</sup>; and his indecision was that, in his criticism of eternal truths "through all his irony, the admittance of several, however miserable, 'eternal truths' is visible... Is 'Plattheiten', Bogdanov asked ironically, the same as 'Wahrheiten'?"<sup>22</sup>.

It should be especially stressed here that the reverent-religious attitude towards the classics and great authorities of Marxian philosophy was absolutely alien to Bogdanov. Accepting the notion that the social materialism of Marx was true (although not absolutely) and becoming an active supporter, Bogdanov, in his development of social-materialistic ideas often criticized one or other of the opinions of Marx and Engels, let alone Plekhanov and the other Russian Marxists. In his works one frequently encounters statements such as: "The fundamental notion of dialectics by Marx, and by Hegel as well, has not reached absolute clarity and completion; and, due to this, the use of the dialectical method itself becomes inexact and diffuse, in its schemes arbitrariness is mixed in and, not only are the boundaries of dialectics are not being defined but sometimes its very meaning is seriously distorted"<sup>23</sup>. Naturally, Bogdanov demonstrates arguments in support of this notion and his criticism of Marxian notions is aimed, in general, at the improvement of Marxian philosophy and is conducted within its framework.

In Bogdanov's philosophical endeavours there was one very important motive: from his point of view the philosophy of Marxism should be a philosophy of modern natural science and in this respect he acted in full accordance with Engels' thesis that "with each epochal discovery, even in the natural-historical field, materialism should inevitably change its form"<sup>24</sup>.

Bogdanov's constant tendency was toward using the results of the natural science of his time in the philosophy of Marxism, thus his unceasing attempts to combine the philosophical principles of Marxism with the achievements of other philosophical conceptions were especially those oriented towards the analysis of scientific cognition. In trying to realize these tasks Bogdanov, being a profoundly creative person, was often carried away and was, quite

possibly, wrong in some respects, though afterwards he would correct his notions and search for new ways of improving of Marxian philosophical theory. In the middle of the first decade of the XX century the combination of basic concepts of Marxian social philosophy with the ideas of Machism and empiriocriticism was considered by Bogdanov to be a very promising area, but in this endeavour he never left the domain of Marxism and never became merely a supporter of E. Mach and R. Avenarius. Therefore the empiriomonism developed by him at that time *is not only and not just a variation on the Machist theme* but, rather, is a real attempt to integrate some of the more interesting ideas of modern philosophy, and which would therefore promote the *improvement of Marxian philosophy*.

Thus it is fair to say that at the turn of the XX century Bogdanov had spent a maximum of effort to help Marxian philosophy absorb all the achievements of the philosophical theories contemporaneous to it. By this he became *one of the first Marxists* to realize such a *model of Marxian philosophical development*, one which was aimed at combating the isolation of Marxism from the general direction of the development of philosophical culture and in which the accent was on the synthesis of the ideas of Marxian philosophy and other philosophical systems. It was in just this way that the actual development of Marxian philosophy went later, especially in the second half of the XX century. In this connection it is sufficient to recollect that in the 1960's-'90's the active "absorption" of many of the ideas of neo-positivism, existentialism, phenomenology, hermeneutics, and other philosophical concepts of the XX century, by Marxism.

On the basis of the abovementioned one should not come to the conclusion that in those philosophical discussions at the beginning of the XX century Bogdanov was absolutely right in every respect and

Plekhanov and Lenin, who, in fact, was following Plekhanov's argumentation, were completely wrong. In philosophy this is never possible: any philosophical concept, even all the greatest philosophical systems, contain many questionable or doubtful issues, have difficulties of their own which are eventually discovered. Naturally the same is true in the case of Bogdanov's empiriomonism but for us, here, another idea is interesting: at the beginning of the XX century empiriomonism *reflected progressive tendencies in the development of philosophy*, the philosophy of Marxism and, in particular, the insurmountable disposition of Plekhanov and especially Lenin to indefinite quotation of Engels without any attempt at a real development of Marxian philosophy is a way into a cul-de-sac which eventually lead Marxian philosophy, especially of the official Soviet variety, to a collapse.

In the meantime history decided otherwise. Empiriomonism and the subsequent achievements of Bogdanov were consigned to oblivion. In the philosophical community of socialist countries for many decades of the XX century Lenin's interpretation of Bogdanov's philosophical writings was paramount. The outcome of those discussions for Bogdanov, on a personal level, was his practical excommunication from revolutionary activity. But every cloud has a silver lining and from the second decade of the XX century Bogdanov completely dedicated himself to scientific work.

In the years 1910 to 1913 he finished work on the first volume of the universal organizational science, that is tektology. It is the end of this work in particular because many of the principal ideas of tektology had been formulated by him in his studies of empiriomonism, a further demonstration that this philosophical concept is progressive.

Actually, empiriomonism also proceeds from the concepts of "experience" and "organizedness", which are presented as basic in

tektology. Bogdanov asserts that we should resolutely reject the characteristic tendency of past philosophy which had been clearly stated by the sensualists; that experience "is subjective, purely individual perception", and which can be reduced to "individual sensations and impressions". This is a "perversion of actual experience, as it is 'directly given' to a knowing subject". "What can we call 'directly-given'? Both things and perceptions, and only both of them constitute the system of experience; both of them are equally the material of cognition"<sup>25</sup>.

In contrast to empiriocriticism, empiriomonism not only recognizes the legitimacy and importance of the concept of causality but also develops its own version of its evolution, whose ultimate form, according to Bogdanov, consists in socially organized labour causality. Similarly, the principal task of scientific knowledge for empiriomonism is the explanation of objects under investigation rather than their description, as it was for empiriocritics.

Within the framework of empiriomonism, Bogdanov also developed the doctrine of sociomorphism, which stresses the universal application in cognition of the so called "basic metaphor". It "represents natural phenomena in conformity with the pattern of human actions"<sup>26</sup>. Besides, Bogdanov develops the idea of "substitution" — a prototype of modelling methods; creates an ingenious concept of objectivity based on the notion of coordinated, socially organized experience, etc.

In empiriomonism Bogdanov formulates the idea of the identity of physical and mental experience, which we consider to be much too strong. Indeed, these elements may be correlated, similar, analogous, etc. but if they are identical, then their relationships must be also identical which is at odds with Bogdanov's own assertions<sup>27</sup>.

Bogdanov had published Part I of the "Universal organizational science (Tektology)"<sup>28</sup> in 1913 and Part (Volume) 2 of this book four years later<sup>29</sup>. The response to this publication was extremely modest. Readers can acquaint themselves with the principal contents of the reviews of Tektology Part I in the "Preface to the First Edition of Part Two", published in the present edition. It seems, that there were a number of reasons for such a cool attitude in relation to Bogdanov's "Tektology", the First world war, and the contemporaneous scientific community being, mildly speaking, not prepared to appreciate such generalized and abstract concepts. Nevertheless, it did not embarrass Bogdanov, and he published an abridged version of "Tektology"<sup>30</sup> in the years 1919 to 1921, and the second edition of "Tektology" with the third Part added, in 1922<sup>31</sup>. A German translation of "Tektology"<sup>32</sup> appeared a little later, in the years 1926 to 1928. And, finally, a third edition of "Tektology"<sup>33</sup> was published in the years 1925 to 1929, the third Part being issued after Bogdanov's death.

Bogdanov returned to Russia in 1914 not long before the First world war began. He spent a year at the front as a medical officer. After the October revolution of 1917 he was engaged in teaching: was a professor of political economy at the Moscow university, one of the founders of the Socialist (later Communist) academy (1918) and a member of its Presidium (1918 to 1926) and worked with the commission for translating works by Marx and Engels into Russian. He took an active part in the discussions on the Russian economy, that took place in the 20s, and in the years 1917 to 1920 became one of the main organizers of "Proletcult" (Proletarian culture), a voluntary cultural, elucidative, literary and artistic organization, that set as its goal the creation of a proletarian culture.

The activities of "Proletcult", which lasted until 1932, contained many disputable and often evidently erroneous points. In this work, Bogdanov stuck to quite reasonable principles, insisting on the



democratization of scientific knowledge on the basis of the creation of a worker's encyclopedia, the organization of workers' universities, the development of proletarian art, etc.<sup>34</sup>, and of course he cannot be held responsible for the many erratic aims and actions of this organization. Besides, a real history of "Proletcult" has not yet been written and Bogdanov's actual role in it has not yet been studied.

Bogdanov was arrested in 1923. No serious charges were brought against him and was soon he discharged.

Bogdanov devoted the last years of his life, practically in full, to research in the field of haematology and gerontology. In 1926 he founded the world's first Institute for Blood Transfusion, and worked as its director to the last day of his life. Bogdanov considered the method of blood transfusion to be a possible method for using the ideas of tektology in medicine, as a means of increasing the vital capacity of the organism and extending human life. Both research and practical work were performed at the Institute. Bogdanov considered it desirable to perform the most risky experiments upon himself. His twelfth experiment had tragic results, he was taken seriously ill and died on the 7 of April 1928<sup>35</sup>.

The fate of Bogdanov's main creations — Empiriomonism and Tektology — turned out to be as tragic as his life. In Soviet Russia, after Lenin's criticism, empiriomonism was the target for merciless criticism for almost a century, without the slightest attempt being made to understand it. Only in the most recent time has real study and research on Bogdanov's empiriomonism<sup>36</sup> been started. As for tektology, it had a long and difficult path to travel before the scientific community of the 20th century accepted its significance and importance.

In Soviet Russia about 30-35 years after Bogdanov's death they preferred not to mention tektology at all, and if it was mentioned then only in a negative sense — in the spirit of criticism which was introduced by the philosopher N. Karev as early as the 1920s; readers can acquaint themselves with these views in the addenda to Part Two (Book Two). Western researchers of Bogdanov's work, who in most part do not read Russian, had simply no opportunity to read or appreciate "Tektology". Neither did the German translation of "Tektology"<sup>37</sup> have any impact on the Western scientific community: apparently it remained quite unknown to them.

Real appraisal of tektology was started only in the years 1960-70 — in the Soviet Union as a result of an ideological thaw, and in the West after publication of the English translation of the abridged version of "Tektology"<sup>38</sup>. Undoubtedly, the publication of the English translation of "Essays in Tektology" gave rise to a certain interest in this theory, and in the personality of Bogdanov, in the West<sup>39</sup>.

The credit for the restoration of the scientific-historical truth about Bogdanov's "Tektology" in the Soviet Union belongs to A.I. Uemov, M.I. Setrov, G.N. Povarov, A.A. Malinovsky (Bogdanov's son and a well known geneticist and resolute anti-Lysenkovist who suffered for this in the period after 1948), E.G. Yudin, I.V. Blauberg, P.K. Anokhin, A.L. Takhtadjan, N.N. Moiseev, and others<sup>40</sup>. It should be stressed that these authors took considerable risk appreciating Bogdanov's "Tektology" in late 60s, early 70s and not infrequently exposed themselves to the fire of ideological criticism.

The restoration of the scientific importance of "Tektology" in the Soviet Union initially took the following form (the one only possible at that time): by no means disclaiming Lenin's criticism of Bogdanov's philosophical mistakes one, nevertheless, should

recognize the scientific importance of "Tektology" — "historically the first version of a general theory of systems" (in such a way, in particular, I.V.Blauberg and E.G.Yudin wrote in 1971<sup>41</sup>). However, at that time and even later, one would encounter dogmatically-orthodox judgments of "Tektology" which, as a matter of course, did not mention its scientific importance but stressed without fail the "subjectively-idealistic and mechanistic mistakes of Bogdanov (we give no examples — however regrettable it may be, they are very numerous).

Nevertheless, in 1970s and 1980s there was gradually worked out ageneral acceptance of Bogdanov's "Tektology" as historically the first version of a general systems conception, which, in many aspects anticipated the ideas of cybernetics, general system theory, and similar concepts, and, one way or another, had influenced them. Thus, M.I. Setrov as early as 1967 noted that "many of the general theoretical problems of the systems approach were developed by Bogdanov much more broadly and more strictly than is done in modern systems theory and cybernetics"<sup>42</sup>.

A general summing up of this appreciation and those similar was done in the article "Bogdanov" (written by A.A. Malinovsky<sup>43</sup>) in the "Philosophical Encyclopedic Dictionary" where the following is said: "Bogdanov proposed the idea of creating a science of universal laws of organization — tektology. Some of the concepts of tektology anticipated the ideas of cybernetics and general system theory (the concept of feedback, the idea of modelling, etc.) and they are one of the theoretical sources of modern systems studies"<sup>44</sup>.

Western researchers have come to a similar evaluation of the importance of Bogdanov's "Tektology". As already mentioned, G. Gorelik, even before publication of his translation of "Essays in Tektology" into English had made an attempt to familiarize the

Western scientific community (in particular the systems community) with the principal ideas of "Tektology", stating, in particular, that "Tektology" was historically the first developed version of General systems theory and a forerunner of cybernetics"<sup>45</sup>. Later speaking about "Tektology" as the "maximum extension of any theory of systems"<sup>46</sup>. Interesting notions about tektology, particularly, about its connection with empiriomonism were also expressed by A.Yassour<sup>47</sup>.

A profound analysis of "Tektology" was done by another Western researcher, Milan Zeleny. In many of his works Zeleny appeals to the ideas of "Tektology" trying to treat them not only from the historical point of view but in the sense of their possible influence on modern systems concepts as well. For example, Zeleny particularly stresses, in one of his articles which especially deals with "Tektology", that "Bogdanov's system (or *complex*) is not simply a collection, aggregate (or vector) of components and their relationships. A system is a *process*, or continuous flux of independent component-producing processes, concatenated in self-triggering circles of build-up and degradation. Bogdanov's system cannot be separated from its environment, because it does not simply exist or interact with its environment: it is *structurally coupled* with its environment and thus evolves its own environment while co-evolving with it"<sup>48</sup>. In Zeleny's opinion this and other ideas in "Tektology" could find interesting applications in modern systems theories.

It seems reasonable to conclude this overview of the history of the restoration of the scientific priority of Bogdanov's tektology in the development of systems ideas' in the 20-th century by referring to a section from the book by R. Mattesich "Instrumental Reasoning and Systems Methodology" entitled "Who is the Father of Theory of Systems — Bogdanov or Bertalanffy?" The author of this book resolves the question quite definitely in favour of Bogdanov and

expresses the utmost surprise as to how L.von Bertalanffy, actively working in the 1920s in the field of theoretical biology, could miss the German edition of "Tektology" in 1926-28 and the book review, and later never mention in all his works the name of A.A.Bogdanov<sup>49</sup>.

In our opinion all the above is quite sufficient for a fair appraisal of "Tektology" (unfortunately the first for many decades, but it is hardly the only occasion in the history of science) as being *historically the first version of the systems theories of the 20th century* the ideas of which can be successfully used in the present time. This, however, does not eliminate the task of further, more profound and more thorough, analysis of the scientific importance of "Tektology" and its possible applications to modern systems conceptions.

As was already mentioned, in the 1980s Bogdanov's tektology at long last received more or less adequate appreciation both in Soviet Russia and abroad. In 1989, 60 years after the last edition of "Tektology" published in his lifetime, a new edition of this classical work<sup>50</sup> was issued in the USSR. In various countries in the 80s and 90s there were conferences organized concerned with the analysis of Bogdanov's works and, primarily, tektology. Particularly, one of the most recent conferences of this kind — the Russian-English conference entitled "Origins of Organization Theory in Russia and in the Soviet Union" — was held in Norwich (England) in January 1995<sup>51</sup>. And finally the leading Russian magazine "Voprosy Filosofii" published in issue No 8 of 1995 a number of articles under the common title "Bogdanov's Tektology and the Present Time" (articles written by L.I. Abalkin, N.N. Moiseev, Yu.A. Urmantsev, S.N. Pustilnik, A.P. Ogurtsov, James D. White and V.N. Sadovsky are based on materials presented at the Norwich Conference)<sup>52</sup>. Thus

finally we can say that at least now Bogdanov's tektology has gained deserved acknowledgment in the science of the 20th century.

It is obvious that the main importance of Bogdanov's tektology consists in the creation of *the foundations of general organizational science*. The organic systemicity of this project is its integral and most significant feature. Bogdanov considered the laws governing the organization of complexes to be identical for any objects. "Complex" is Bogdanov's version of the modern notion "system", and therewith it is treated not as merely a set of interrelated elements, but rather as a process of change in their organization stemming from the structural connection of the complex with its environment. In "Tektology" Bogdanov defined universal types of systems and analyzed the basic organizational mechanism — selection. The latter may be positive or negative, and, mutually complementing each other, these two forms organize the whole world. Bogdanov investigated a number of other aspects of organizational development: the divergence and convergence of forms, the results of selection, the types of systems crises which arise in the processes of organization and deorganization, etc. It should be also added that in "Tektology" the idea of feedback (in the form of the bi-regulator) was anticipated, and in fact he formulated the idea of systems isomorphism on which both the cybernetics of N.Wiener and W.Ross Ashby and the General System Theory of L.von Bertalanffy were based. To put it differently, Bogdanov's universal organizational science, or tektology, not only anticipated cybernetics, general systems theory, and similar concepts but also *profoundly expressed the main methodological orientation of science, technology and practical activity of the 20th century*. It is in that where the intransient importance of tektology lies.

However, along with this, the reader must pay attention to many inexactitudes and sometimes, simply mistakes, in Bogdanov's

interpretations of his data taken from physics, biology, linguistics and from other sciences. There is nothing unusual in this: tektology was created at the beginning of the 20th century, and Bogdanov, in spite of his encyclopedic knowledge, certainly could not, so to speak, "jump out" beyond the level of knowledge of those times. An overwhelming number of examples from various sciences were used and illustrate quite well his tektological principles, and here lies their basic sense while the inexactitudes and mistakes made in the process are an obvious tribute to the time, the reader should accept them just with such an attitude.

This translation of Bogdanov's "Universal Organizational Science (Tektology)" presented to the reader is the first complete translation of this work into English. The translation was taken primarily from the third (published in his life-time) edition issued in 1925-1929<sup>53</sup>. The first and second editions of "Tektology"; the abridged version of this work and its translation into English (made by G.Gorelik); the first volume of the German translation, and the edition of "Tektology" of 1989<sup>54</sup> were also consulted. In comparison with the edition of 1989 it was deemed possible to include all the addenda to Part Three (in the edition of 1989 four of them were excluded), and also to correct numerous errors and inexactitudes which were found in that edition. To provide a more complete representation of Bogdanov's views it was considered expedient to include the section "Hedonistic Selection" into Chapter VII "Ways and Results of Selection" which was in the first and the second editions but was omitted by Bogdanov from the third edition.

The work on the translation of a book of such size and technical complexity as Bogdanov's "Universal Organizational Science (Tektology)" has taken almost two years of intensive work. And we now flatter ourselves with the hope that this work will be useful for English-speaking readers, and it would attract further interest to the

scientific and philosophical work of Alexander Alexandrovich Bogdanov.

Vadim N. Sadovsky, Vladimir V. Kelle, March 1996.

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<sup>1</sup>The work for this paper was partly supported by the Russian Foundation for Basic Research: Grant 96-06-80513.

<sup>2</sup>The province of Grodno is in Western Byelorussia. Of the other Russian towns mentioned in this paper Tula, Kaluga and Vologda are situated in Central European Russia and Kharkov is in Eastern Ukraine.

<sup>3</sup>Narodism (народничество) was the most widely spread form of revolutionary activity in Russia during the last third of the nineteenth century. It expressed the interests of the peasants against the capitalist form of development in Russia and was in favour of the overthrow of tsarist autocracy through a peasants' revolution. As an ideology, Narodism was a form of peasant-communal socialist utopia, to which many of the *razochinny intelligentsia* (intellectuals not belonging to the gentry) were attracted. In the 1890's the leaders of the Russian social democracy movement, including amongst others G.V. Plekhanov and V.I. Lenin, subjected the ideas of Narodism to severe criticism showing in particular its utopianism and lack of any real prospects for success

<sup>4</sup>A.A. Богданов, *Краткий курс экономической науки*, Москва, Книжный склад А. Муриковой, 1897, 290 с. (A.A. Bogdanov, *A Short course of Economic Science* (trans. J. Fineberg), CPGB, London, 1923).

<sup>5</sup>*Ibid.*, sixth edition, Moscow, 1905, 294 p. (in Russian).

<sup>6</sup>A.A. Богданов, *Основные элементы исторического взгляда на природу*, Спб, Издатель, 1899, 261 с. (A.A. Bogdanov, *Principal Elements of the Historical View of Nature*, St. Petersburg, 1899, 261 p.).

<sup>7</sup>A.A. Богданов, *Познание с исторической точки зрения*, Спб, Издание автора, 1901, 217 с. (A.A. Bogdanov, *Knowledge from the Historical Viewpoint*, St. Petersburg, Published by the author, 1901, 217 p.).



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<sup>8</sup>At the II RSDLP Congress of 1903 the party split into two factions — the bolsheviks (with Lenin as the leader) and the mensheviks (with Plekanov as the leader). Lenin's faction had a majority at the Congress hence the word "bolshevik" derived from the Russian word for "majority" (большинство) and "menshevik" from the Russian for minority (меньшинство).

<sup>9</sup>А.А. Богданов, Эмпириомонизм: статьи по философии, Книга 1, Москва, Дороватовский и Чарушников, 1904, А.А. Богданов, Эмпириомонизм: статьи по философии, Книга 2, Москва, Дороватовский и Чарушников, 1905, А.А. Богданов, Эмпириомонизм: статьи по философии, Книга 3, Москва, Дороватовский и Чарушников, 1906, (A.A. Bogdanov, Empiriomonism: Papers in Philosophy, Book 1, Moscow, 1904; Book, Moscow, 1905.; Book 3, Moscow, 1906.).

<sup>10</sup>А.А. Богданов, Страна идолов и философия марксизма // Очерки по философии марксизма, Спб, 1908, сс. 215-242 (A.A. Bogdanov, Land of Idols and Marxist Philosophy // Essays in Marxist Philosophy, St. Petersburg, 1908, pp. 215-242). А.А.Богданов. Философия современного естествоиспытателя // Очерки философии коллективизма, Сб. 1, Спб., 1909, сс. 35-142 (A.A. Bogdanov, A Modern Naturalists Philosophy // Essays in Collectivist Philosophy, Collection 1, St. Petersburg, 1909, pp. 35-142). А.А.Богданов, Открытое письмо тов. Плеханову // Вестник жизни, 1907, сс. 47-51 (A.A. Bogdanov, An Open Letter to Comrade Plekhanov // Journal of Life, 1907, No. 7, pp. 47-51). А.А. Богданов, Красная Звезда: Роман-Утопия, Спб. издание автора, 1908, 156 с. (A.A. Bogdanov, Red Star: A Utopian Novel, published by the author, St. Petersburg, 1908) and other works.

<sup>11</sup>А.А. Богданов, Открытое письмо тов. Плеханову // Вестник жизни, 1907, 7, сс. 47-51. (A.A. Bogdanov, An Open Letter to Comrade Plekhanov // Journal of Life, 1907, No. 7, pp. 47-51).

<sup>12</sup>Г.В. Плеханов, Materialismus Militans: Ответ господину Богданову, Письмо первое // Голос социал-демократа, 1908. № 6-7 (май-июнь); Письмо второе // Голос социал-демократа, 1908. № 8-9 (июль-сентябрь); Письмо первое, второе и третье // Г.В. Плеханов, От обороны к нападению, Спб., 1910 (G. V. Plekhanov, Materialismus Militans: A Reply to Mr. Bogdanov, first letter // The Voice of the Social Democrat, 1908, No. 6-7 (May - June); The second Letter // The Voice of the Social Democrat, 1908, No. 8-9 (July-September); The first, second and third letters // G.V. Plekhanov, From Defence to Attack, St. Petersburg, 1910). See also: Г.В. Плеханов, Избранные философские

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сочинения, Том. III, Москва, Госполитиздат, 1957, сс. 202-301 (G.V. Plekhanov, Selection of Philosophical Works, Vol. III, Moscow State Publishing House of Political Literature, 1957, pp. 202-301).

<sup>13</sup>Lenin, V. I.,

<sup>14</sup>А.А.Богданов, Вера и наука (О книге В. Ильина "Материализм и эмпириокритицизм") // А.А.Богданов, Падение великого фетишизма. Вера и наука, Спб., Дороватовский и Чарушников, 1910, сс. 144-223 (A. A. Bogdanov, Belief and Science (About a Book by V. Iljin "Materialism and Empiriocriticism") // A.A. Bogdanov, The Fall of the Great Fetishism. Belief and Science, Dorovatovsky and Charushnikov, St. Petersburg, 1910, pp. 144-223).

<sup>15</sup>Т.С. Ищенко, Краткий философский словарь, Москва, Издательство Коммунистического университета им. Я.М. Свердлова, 1930, сс. 31-33, 236-238 (A Short Dictionary of Philosophy, Moscow, Ja. M. Sverdlov, Communist University Press, 1930, pp. 31-33, 236-238); Краткий философский словарь, Под редакцией М. Розенталя и П. Юдина, Государственное издательство политической литературы, 1939, сс. 25-26, 312-313 (A Short Dictionary of Philosophy, M. Rosenthal and P. Yudin, eds., State Publishing House of Political Literature, 1939, pp. 26-26, 312-313). This standard official interpretation of the "great" or "basic work of philosophy by Lenin", though in a more civilized form was retained until as late as the 1980's for example in М.П. Гапочка, "Материализм и эмпириокритицизм", Философский энциклопедический словарь, 2-е изд., Москва, "Советская энциклопедия", 1989, сс. 347-348. (M.P. Gapochka, Materialism and Empiriocriticism // Encyclopaedic Dictionary of Philosophy, 2nd. ed., Moscow, "Soviet Encyclopaedia", 1989, pp. 347-348).

<sup>16</sup>А.А. Богданов, Философия живого опыта: Популярные очерки: Материализм, эмпириокритицизм, диалектический материализм, эмпириомонизм, наука будущего, Спб., Изд. М.И. Семенова, 1913, 272 с.; 2-е изд., Москва, Госиздат, 1920, 256 с.; 3-е изд., Петроград-Москва, Книга, 1923, 347 с. (A.A. Bogdanov, Philosophy of Living Experience: Popular Essays: Materialism, Empiriocriticism, Dialectical Materialism, Empiriomonism, Future Science, St. Petersburg, M.I. Semenov, 1913; 2nd. ed., Moscow State Publishing House, 1920; 3rd. ed. Petrograd, Moscow, Книга, 1923).

<sup>17</sup>А.А. Богданов, Философия живого опыта, 3-е изд., Петроград-Москва 1923, 347с. (A.A. Bogdanov, Philosophy of Living Experience, 3rd. ed. Petrograd-Moscow, 1923).

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<sup>18</sup>А.А.Богданов. Эмпириомонизм: статьи по философии, Книга III (A.A. Bogdanov, *Empiriomonism: Papers in Philosophy, Book III*).

<sup>19</sup>*Ibid.*

<sup>20</sup>*Ibid.*

<sup>21</sup>*Ibid.*

<sup>22</sup>*Ibid.*

<sup>23</sup>А.А. Богданов, Философия живого опыта, 3-е изд., 347 с. (A.A. Bogdanov, *Philosophy of Living Experience, 3rd. ed. Petrograd-Moscow, 1923*).

<sup>24</sup>К. Маркс, Ф. Энгельс, Сочинения, Том 21, 286 с. (K. Marx, F. Engels, *Writings, Vol. 21*).

<sup>25</sup>А.А. Богданов, Философия живого опыта, 3-ое изд., 347 с. (A.A. Bogdanov, *Philosophy of Living Experience, 3rd. ed., Petrograd-Moscow, 1923*).

<sup>26</sup>*Ibid.*

<sup>27</sup>See A. Yassour, *The Empiriomonist Critique of Dialectical Materialism: Bogdanov, Piekhanov, Lenin // Studies in Soviet Thought, Vol. 26, 1983, pp. 21-38; V.N. Sadovsky, A. Bogdanov's Empiriomonism: A Forgotten Chapter in the Philosophy of Science // 10th International Congress of Logic, Methodology and Philosophy of Science, Florence, Aug., 1995; В.Н. Садовский, Эмпириомонизм А.А. Богданова: забытая глава философии науки // Вопросы философии, 1995, № 8. сс. 50-62. (V.N. Sadovsky, A. Bogdanov's Empiriomonism: A Forgotten Chapter in the Philosophy of Science // Questions of Philosophy, 1995, No. 8, pp.*

<sup>28</sup>А.А. Богданов, Всеобщая организационная наука (Тектология), Часть 1, Спб., Изд. М.И. Семёнова, 1913, 255 с. (A.A. Bogdanov, *Universal Organizational Science (Tektology), Part 1, St. Petersburg, M.I. Semenov, 1913*).

<sup>29</sup>А.А. Богданов, Всеобщая организационная наука (Тектология), Том 2, Москва, Кн. изд-во писателей в Москве, 1917, 153 с. (A.A. Bogdanov, *Universal Organizational Science (Tektology), Book 2, Moscow, Moscow Writers Publishing House, 1917*).

<sup>30</sup>А.А. Богданов, Очерки всеобщей организационной науки // Пролетарская культура, Москва, 1919, № 7-8, сс. 8-29; № 9-10, сс. 5-20; № 11-12, сс. 10-26; 1920, № 13-14, сс. 16-43; № 15-16, сс. 6-38; № 17-19, сс. 6-32; 1921, № 20-21, сс. 3-19. А.А. Богданов, Очерки всеобщей организационной науки, Самара, Госиздат, 1921, 322 с. (A.A. Bogdanov, *Essays in Organizational Science // Proletarian Culture, Moscow, 1919-*

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1921, No. 7-21). In 1921 Bogdanov published these papers in book form as *Essays on Universal Organizational Science*, Samara, State Publishing House, 1921).

<sup>31</sup>The second edition of "Tektology" was printed in Berlin by Grjebin in 1922; it included the first two parts and the newly written third: А.А.Богданов. Тектология: Всеобщая организационная наука, Части 1 и 2, 2-е изд. заново переработанное и дополненное; Часть 3, 1-е изд., Берлин-Петроград-Москва, изд. З.И. Гржебина, 530 с. (А.А. Bogdanov, *Tektology: Universal Organizational Science, Parts 1 and 2, 2nd ed. Part 3, 1st ed.*, Berlin, Petrograd, Moscow, Z.I. Grjebin, 1922).

<sup>32</sup>А.А. Bogdanov, *Allgemeine Organisationslehre (Tektologie)*, Bd. 1, Berlin, 1926, Bd. 2, Berlin, Hirzel, 1928).

<sup>33</sup>А.А. Богданов, *Всеобщая организационная наука, Тектология: Ленинград-Москва, "Книга"*, Часть 1, 3-е изд., заново переработанное и дополненное, 1925, 300 с.; Часть 2, 3-е изд., заново переработанное и дополненное, 1927, 268 с.; Часть 3, 3-е изд., заново переработанное и дополненное, 1929, 230 с. (А.А. Bogdanov, *Universal Organizational Science (Tektology)*, Leningrad-Moscow, "Kniga" Publishing House, Part 1, 3rd ed., revised, 1925; Part 2, 3rd. ed., revised, 1927; Part 3, 2nd. ed., supplemented, 1929).

<sup>34</sup>А.А. Богданов, *О пролетарской культуре: 1904-1924*, Ленинград-Москва, "Книга", 1924 (А.А. Bogdanov, *On Proletarian Culture: 1904-1924*, Leningrad-Moscow, "Kniga", 1924).

<sup>35</sup>Detailed biographical information can be found in the article "А.А.Богданов, Биографический очерк" // А.А. Богданов, *Тектология. Всеобщая организационная наука, Книга 1*, Москва, Экономика, 1989 (А.А. Bogdanov, *Biographical Essay // А.А. Bogdanov Tektology, General Organizational Science, Book 1*, Moscow, *Ekonomika*, 1989). This article was written by G. D. Gloveli who was not named. Gloveli's article is used in this paper. See also the article "Bogdanov" in the book *Философы России XIX-XX столетий*, Изд. 2, Москва, "Книга и бизнес", 1995, сс. 75-76 (*Philosophers of Russia of the XIX-XX Centuries*, 2nd ed., Moscow, *Kniga i Biznes*, 1995).

<sup>36</sup>See A. Yassour, *The Empiriomonist Critique of Dialectical Materialism: Bogdanov, Plekhanov, Lenin // Studies in Soviet Thought*, Vol. 26, 1983, pp. 21-38; V.N. Sadovsky, A. Bogdanov's Empiriomonism: A Forgotten Chapter in the Philosophy of Science // 10th International Congress of Logic, Methodology and Philosophy of Science, Florence, Aug., 1995;

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В.Н. Садовский, Эмпириомонизм А.А. Богданова: забытая глава философии науки // *Вопросы философии*, 1995, № 8. сс. 50-62. (V.N. Sadovsky, A. Bogdanov's Empiriomonism: A Forgotten Chapter in the Philosophy of Science // *Questions of Philosophy*, 1995, No. 8, pp. 50-62).

<sup>37</sup>See note 39.

<sup>38</sup>See note 29.

<sup>39</sup>A.A. Bogdanov, *Essays in Tektology*, English translation by George Gorelik, *Systems Enquiry Series*, Intersystems Publications, 1980.

<sup>40</sup>Let me name the most important studies which made the first steps toward restoring Bogdanov's scientific merits А.И. Уемов, *Некоторые тенденции в развитии естественных наук* // *Вопросы философии*, 1961 ( A.I. Ujemov, *Some Tendencies in the Development of Natural Sciences and the Principles of their Classification*, *Questions of philosophy*, 1961); М.И. Сетров, *Об общих элементах тектологии А.Богданова. кибернетики и теории систем* // *Ученые записки кафедр общественных наук вузов Ленинграда, Серия "Философия"*, Вып 8, Ленинград, 1967 ( M.I. Setrov, *On Common Elements in Bogdanov's Tektology, Cybernetics and Systems Theory* // *Scientific Reports of Societal Science Chairs of Leningrad Institutes, Series Philosophy*, № 8, Leningrad, 1967); Г.Н. Поваров, *Норберт Винер и его "Кибернетика"* // *Н. Винер, Кибернетика или управление и связь в животном и машине*, Москва, Советское радио, 1968 (G.N. Povarov, *Norbert Wiener and his Cybernetics* // N. Wiener, *Cybernetics or Control and Communication in the Animal and the Machine*, Moscow, Sovietskoe radio, 1968). И.В. Блауберг, В.Н. Садовский, Э.Г. Юдин, *Системный подход: предпосылки, проблемы, трудности*, Москва, 1969 (Blauberg, Sadovsky and Yudin, *The Systems Approach: Prerequisites, Problems and Difficulties*, Moscow, 1969); А.А. Малиновский, *Богданов* // *Большая Советская энциклопедия*, Том 3, 1970 (A.A. Malinovsky, *Bogdanov* // *The Great Soviet Encyclopaedia*, vol. 3, 1970); А.Л. Тахтаджан, *Тектология: История и проблемы* // *Системные исследования. Ежегодник 1971*, Москва, "Наука", 1972 ( A.L. Takhtadjan, *Tektology: Its History and Problems* // *Systems Research Yearbook*, 1971, Moscow, Nauka, 1982); Н.Н. Момсеев, *Человек. Среда. Общество*, Москва, "Наука", 1982. The list can be easily extended.

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<sup>41</sup>"Системные исследования", Ежегодник 1971, Москва, "Наука", 1972 с. 201 ( A.L. Takhtadjan, *Tektology: Its History and Problems // Systems Research Yearbook, 1971, Moscow, Nauka, 1982*).

<sup>42</sup>М.И. Сетров, Об общих элементах тектологии А.Богданова. кибнетники и теории систем // Ученые записки кафедр общественных наук вузов Ленинграда, Серия "Философия", Вып 8, Ленинград, 1967, с. 59 (M.I. Setrov, *On Common Elements in Bogdanov's Tektology, Cybernetics and Systems Theory // Scientific Reports of Societal Science Chairs. of Leningrad institutes, Series Philosophy, No 8, Leningrad, 1967*).

<sup>43</sup>Bogdanov's son A.A. Malinovsky was widely using ideas introduced in Tektology especially in the 1960's to the 1980's, see Zeleny, *On the Systems Writings of A.A. Malinovskii (Malinovsky) // International Journal of General Systems, 15, No. 3, 1989*).

<sup>44</sup>А.А. Малиновский, Богданов А.А. // Философский энциклопедический словарь, 2 изд., Москва, "Советская энциклопедия", 1989, с. 64 (A. A. Malinovsky, Bogdanov, A.A. // *Encyclopaedic Dictionary of Philosophy, 2nd. ed., Moscow, Soviet Encyclopaedia, 1989, p. 64*).

<sup>45</sup>See Gorelik, *Principal Ideas of Bogdanov's Tektology // General Systems, A Yearbook, Vol. XX, 1975*).

<sup>46</sup>Gorelik, G. *Bogdanov's Tektology, General System Theory and Cybernetics // Cybernetics and Systems, 18, No. 2*).

<sup>47</sup>See A. Yassour, *The Empirionomist Critique of Dialectical Materialism: Bogdanov, Plekhanov and Lenin " Studies in Soviet Thought, vol. 26, 1983*).

<sup>48</sup>M. Zeleny, *Tectology, International Journal of General Systems, 14, No. 4, 1988*.

<sup>49</sup>See R. Matesich, *Instrumental Reasoning and Systems Methodology, Dordrecht, Boston, D. Reidel, 1978*.

<sup>50</sup>А.А. Богданов, Тектология. Всеобщая организационная наука, Книга 1, Москва, Экономика, 1989, 304 с.; Книга 2, Москва, Экономика, 1989, 351 с. (A.A. Bogdanov, *Tektology. The Universal Organizational Science, Books 1 and 2, Moscow, Ekonomika, 1989*).

<sup>51</sup>International Conference "Origins of Organization Theory in Russia and the Soviet Union", University of East Anglia, Norwich, January 1995.

<sup>52</sup>See "Voprosy Filosofii, 1995, No. 8, pp. 3-62.

<sup>53</sup>See note 49.

<sup>54</sup>See notes 27-31 and 49.





## Editor's Introduction

Peter Dudley

I have two main aims in writing this introduction. The first is to tell the story of how this edition, the first English language translation of the Tektology, came to be; the second is to provide, for the reader new to the Tektology some thoughts on the contents and value of Bogdanov's unique formulation. Beyond this, Vadim Sadovsky and Vladimir Kelle provide, in their foreword, an insight into their views as to the origins and development of the thought of Bogdanov which led to the creation of the Tektology.

Before beginning there are a few people I wish to thank. Bob Flood and Mike Jackson, the current and previous directors of the Centre for Systems Studies who both showed great foresight, in taking on trust the value of a large and complex project which had become a passion for me. Vladimir Kelle for spending many hours patiently explaining the finer points of the Russian language and listening to my suggestions for retaining the meaning of the terminology on its journey into English. Finally Vadim Sadovsky, his work as technical editor of the translation has been invaluable and the completion of this first stage of the project would have been unthinkable without his advice and support — to date the project has been underway for two years and during that time I have been proud to call him friend.

Five or so years ago I was dining with a Russian colleague, the conversation turned to the subject of the origins of systems theory. With typical western arrogance I was propounding the achievements of writers such as von Bertalanffy, Weiner, Ashby, etc., at this point in the proceedings he chose to tell me of Bogdanov and the Tektology. As the evening wore on a picture of a *universal man*

emerged and I was irredeemably hooked. Over the following months I managed to prise more and more detail out of him, Bogdanov's life story, his broad, almost incredible, intellectual interests and his problems with Lenin and orthodox Marxism. However, the institution where I was working was primarily a teaching institution and it seemed that my interest was not to be satisfied. Then serendipity stepped in. In October 1992 I moved to the Centre for Systems Studies at the University of Hull, during a pre-commencement meeting I mentioned my interest in Bogdanov and the Tektology to Mike Jackson who told me of George Gorelik's translation of "Essays in Tektology"<sup>1</sup> and the trail seemed to be re-opening.

About a year later I met Wojciech Gasparski, with whom I was later to co-operate on the re-edition of "Kotarbinski's Praxiology"<sup>2</sup>, for the first time. As was my wont, I began to regale him with the story of the Tektology. It was him who told me of Vadim Sadovsky's involvement in the production of the 1989 edition of the Tektology<sup>3</sup>, the first since Bogdanov's death in 1928. A little later I travelled to Moscow to speak to Vadim Sadovsky and the die was cast for this translation.

As with all works taken across languages, there is a question regarding the extent to which the finished article is a *translation* and the extent to which it is an *interpretation*. Vadim Sadovsky, his team at the Institute for Systems Analysis of the Russian Academy of Science and I are all *systemists*, for want of a better word. Thus any interpretation brought into the work will tend to be biased toward an increased *systemization* of the Tektology. I am not, and cannot be, sure as to how much of a problem this is. Personally I believe the systemic nature of the Tektology pervades every nook and cranny of the work and, as it has been noted by such eminent scholars as, for

example, Gorelik, Sadovsky, Susiluoto and Zeleny<sup>4</sup>, do not feel that the possibility of a slight introduced bias is necessarily fatal.

In this first of three parts Bogdanov sets out the ground for the Tektology. In this book he describes the notions and historical necessity of Tektology, lays out its concepts, methods and its relationship to the philosophy and science of its time. He goes on to explore what he called the "Basic Organization Mechanisms", the formative and the regulative, and the possibility and conditions of "The Stability and Organization of Forms".

It is obvious that Bogdanov intended the Tektology as an *empirical science* as I have argued elsewhere with together with Simona Pustylnik<sup>5</sup>; and that as his Marxist leanings convinced him that such a science as Tektology was necessarily proletarian in nature, the role of Tektology was to change the world not merely contemplate its unity. Below I shall expound my understanding of the Tektology and the extent to which I consider it to be valuable to modern systems researchers.

One of the great problems of contemporary systems theory is the inability to integrate the various ontological grounds which underpin the many systems approaches. If one accepts the various available approaches as *metaphors for* rather than, strictly, *descriptions of* reality, this is, perhaps, not so great a problem. If however, one adopts the opposite view, the importance and size of the problem grows. Bogdanov required of the Tektology that it be a Science in the strong sense — therefore it needed a sound empirical base. However his second requirement — that it also be universally applicable meant that he needed to bring together, in a continuous model, "physical" and "psychic" phenomena in such a way that they were both susceptible to Tektological methods, i.e. that they could be both understood and manipulated using the *same* methods.

The ontological bases of the various systems approaches, from von Bertalanffy's GST onwards, fall into the category of either idealism or materialism. However such ontologies are rarely explicitly stated, systems theory, it seems, is largely epistemological, concerned more with ways of knowing than with the nature of what is known "in itself". von Bertalanffy's GST<sup>6</sup>, the cybernetic models of Wiener<sup>7</sup> or Ashby<sup>8</sup> and Prigogine's "self organizing systems"<sup>9</sup>, all assume a material world, where systemic models are used to create entities for knowing and which are investigated using primarily statistical methods. The same is true of the managerialist models, both Beer's Viable System Model<sup>10</sup> and Checkland's Soft Systems Methodology<sup>11</sup> accept a material "reality" of which their methods provide a way of knowing and, potentially, controlling.

The "Critical Systems School" by taking the step into "methodological complementarity" brings us full circle. At one end of the scale the managerial need to deal with "fundamentally different problem situations" in a planned and systemic manner is isomorphic with the physicists need to deal with the "fundamentally different processes of micro and macro level systems, that is, those systems which obey the time-reversible laws of classical physics and those which obey the time-irreversible second law of thermodynamics. Put simply, the implication of the complementarity approach is that methodological complementarity is necessary because of ontological differences, in short, the cosmos consists in fundamentally and irreducibly different spheres.

Two points arise from the previous discussion: first that all theories of extant, rather than speculative, systems, in fact that body of knowledge that we would identify as *Systems Theory*, has a predominantly, if largely implicit or covert, materialist ontology; and second that the need for complementarity, however altruistically

intended, implies an epistemological weakness. Thus our ways of *particular* knowing are preventing us from achieving *general* knowing, the acceptance of the strict necessity of complementarism precludes the need for integration.

Bogdanov's starting point was that the world exists entirely as *organization* — this is its first similarity with systems theory. This begs the question "If the world *is organization*, what is organized?". Bogdanov gives two answers, reflecting the two meanings we give to the word. Complexes — the results of organization — are comprised of elements *and their inter-relationships* — specific elements are organized into specific complexes by virtue of their specific inter-relationships. Thus, in the first sense of the word, *elements* are organized, they are subject to the *process* of organization. Complexes, however, display the *quality of organizedness*, they are the *outcomes* of the process of organization, and are, therefore, organized in the second sense of the word. Thus for Bogdanov the world consisted of complexes which, in their turn, consisted of elements inter-related in specific ways.

This leads to the ontological questions "What are elements?", and, "What are inter-relationships?". The first question Bogdanov answers in the following manner:

"The world of experience, both physical and psychic, is entirely composed of *elements* — spatial, tactile, accoustical, thermal, etc.. Combinations of these elements make up different "phenomena", both psychic and physical. If the law of causality, inferred for all these phenomena — i.e. for the world of *elements connected by various relations* — is applicable to "things in themselves" serving as an *immediate link* between "phenomena" and "things", it is clear that

"phenomena" and "things in themselves" are of the *same nature*. "Things in themselves" would then represent a direct continuation of the world of *empirical elements* and in fact would be only *combinations of elements*."<sup>12</sup>

From this we can see not only Bogdanov's systemic bent, but also his general definition of *elements*. Elements are *objects of experience*, which, by virtue of "acknowledg[ing] the law of causality to be applicable to "things in themselves"" are as *real* as is the nature of experience. If the world we experience has a basis other than the purely psychic it must have an external cause, — the "things in themselves" — and, because of this causal link between phenomena and experience and the link between elements and phenomena; the mental world of representation and the external world of "things in themselves" are joined as links in a single causal chain. This "primary correlation" is the basis of Bogdanov's monism. Neither materialism nor idealism is prioritized because neither is sufficient, in isolation to produce *experience*; experience consists *necessarily* both in those "things in themselves" which "produce sensations" *and* in their cognition.

Thus, as changes in the phenomena we experience evidently occur, it is reasonable to assume that the "things in themselves", which are supposed to underlie them, are changing too, at least in terms of the inter-relationships which constitute the phenomena under observation, and, as we as actors can carry out specific acts and experience predictable outcomes as their result, it is also reasonable to assume that the law of causality applies to the "things in themselves". Therefore it is also reasonable to assume that the phenomena we experience reflects the "things in themselves". The complexes we observe and manipulate are phenomena, which reflect, in some way "things in themselves", and the phenomena we

experience are complex, consisting of elements and their inter-relations, which are, of course also phenomena which we experience and so on; therefore "things in themselves" are complex, i.e. consisting of elements and their inter-relations.

This, rather tortuous, reasoning gives us an ontological ground for complexes, elements and inter-relationships; they are all phenomena and therefore part of the causal chain of experience which links individual cognition to *reality*. However it tells us very little about elements other than that they are the parts into which complexes can be decomposed. And it tells us equally little about inter-relationships other than that they are the "glue" which binds elements into complexes. Perhaps we should return to Bogdanov's conception of organization for a clue.

Organizedness, for Bogdanov was relative, it depended on the point of view of the observer, actions or outcomes which were organizationally positive under one set of circumstances could, equally, be organizationally negative under another. In order to clarify his meaning in this respect Bogdanov categorized the organizedness of complexes in relation to the goals which were imputed to them. We can demonstrate this using a simple example:

An entrepreneur has a sum of money which he wishes to invest in a project with the aim of making a profit, the project carries a certain risk of failure and the current bank borrowing rate is constant. Therefore the baseline for success is a return on investment of the current bank rate plus a calculated risk premium. If the project makes a return above this baseline it would be regarded, by Bogdanov, as *organized*, if it makes a return equal to it, it would be regarded as *neutral* and if it makes a return below it, it would be regarded as *de-organized*. Thus the *organized* complex is one which is greater than the sum of its parts — another similarity with systems

theory. However, if the complex is set a different goal — minimizing pollution for example — it may be that the project which was *least organized* from the return on investment point of view becomes the *most organized* from the ecological point of view. In analysing the success or failure of his projects the entrepreneur will almost certainly decompose them into different parts or *elements* in order to understand the causes — supply costs, work rates, fuel consumption, etc., in the case of profit, and perhaps re-cyclability of waste, bio-degradability of constituents and air pollution etc., in the case of ecology consciousness.

Elements it seems are wholly "conventional" they are those parts it is *advantageous* to decompose a complex into in order to achieve a given task or goal.

In defining the "elements of organization" specifically, Bogdanov uses the term "activities-resistances" in order to convey the "relativity" inherent in his "organizational point of view" — what is positively valorized from the point of view of one complex, an "activity" — is negatively valorized from the point of view of another, opposing complex — a "resistance".

Inter-relationships, therefore, must also be relative, if we change the elements of a complex by changing its tasks or goals, surely the relationships between them must also change. This is a rather more difficult point. It would be difficult to deny that the internal relationships of the internal combustion engine are fundamentally the same whether we regard the motor car as a mode of transport or as an air pollution system, way may, however choose to manipulate or assign values to them in different ways in order to satisfy different "wider system" or environmental imperatives. The answer seems to be that, at some level *observed* interactions are *motive independent*



— although at all levels our *classification* of them as *organizing, neutral* or *de-organizing* will remain *motive dependant*.

Let us review our discoveries. Bogdanov considers the world to consist of *complexes* and that these complexes are made up of *elements* and their *inter-relationships*. Complexes, elements and inter-relationships as objects of experience are part of a single causal chain which connects the mental world of representations to the external world of "things in themselves". Elements, complexes and inter-relationships are conventional entities which we use in order to arrange our experience of the world and which can display, enhance or reduce the qualities of *organizedness* (positive), *neutrality* or *de-organizedness* (negative) in relation to specific goals<sup>13</sup>.

This brings us to a point where an embryonic systems theory can be identified. Beyond the notions of complexity and organizedness, the relationship of the elements to the whole implies a notion of hierarchy, and the implications of conventionality and relativity in conjunction with the idea of element as phenomenon leads to the notion of recursively applicable decomposition.

Tektology was intended as an empirical science, however, and experience, whatever its ground, is primarily a personal affair. Nothing that has been said above provides the basis for a science in the strict sense. Bogdanov, as a Marxist, put his faith in the "social nature of knowledge. Vucinich sums up this argument as follows:

"In brief psychical elements make up the experience that is dependent on the "individual subject"; physical elements make up the experience that is dependant on the "collective subject" ... Socialized knowledge, that is knowledge based on physical elements appears ... in two basic forms: technology and ideology ... Both are

systems of knowledge and knowledge is the basic tool of human development." <sup>14</sup>

As we can see from this Bogdanov creates the physical world from the psychical, the shared or "socialized" experience of the group creates "objective" knowledge from individual "subjective" experience and so the ground for Tektology, physical experience, is prepared. The second point, the relation between technology and ideology as the "basic tools of human development", removes the possibility of a strictly objective knowledge, reducing the "truth" of any knowledge to a "that time" truth, as Sadovsky and Kelle point out in their foreword. Thus the value and use of Tektology is necessarily socially determined because the "physical knowledge" upon which it is based is also "socially determined".

And so, thus far we have a body of knowledge which displays many of the characteristics of modern systems theory and which is grounded in a physical knowledge underwritten by social or shared experience. Further, it is adaptive, in that the knowledge on which it is based is adaptive, the dynamic of technology and ideology which drives society will drive the development of Tektology as well. However the complexes as defined above are static, what is needed is a process of development.

Bogdanov provides this in the notion of "selection" <sup>15</sup>. Selection in Tektology operates through a tendency, between or within complexes, toward equilibrium, Zeleny calls this process "equilibration" <sup>16</sup>. Generally, in this process emergent combinations which result in conditions which most closely approximate a local equilibrium tend to persist whilst those which move away from or violate local equilibrium do not. "Conservative" selection, the first category Bogdanov introduces, is concerned solely with existence, whether or not the complex survives, therefore it is a boundary case.

The second category, "progressive" selection regulates the development of the complex. Positive progressive selection results in the growth of the complex, it "assimilates" more from its environment than it releases back, whilst under negative selection the opposite is the case. The possibilities for the continuation progressive selection in any one direction are necessarily limited; in the case of negative selection by the destruction of the complex through attrition and, in the case of positive selection, by the need for radical re-organization, Bogdanov calls these limits "crises". A further point is the location of the equilibrium, in "conservative" selection it is internal, whereas for "progressive" selection it is the equilibrium of the wider system which is capable of drawing internal equilibrium away from its preferred state and thus causing crises.

The crisis of the destruction of the complex is relatively self explanatory, however the crisis of positive selection is rather more interesting. The increase in size brings an increase in complexity up to and until the complex is no longer able to maintain itself under its present structure, at that point the process of equilibration forces a re-structuring which results either in the destruction of the complex in its present form, i.e. it disintegrates, that is it restructures into simpler complexes closer to the local equilibrium state, or its structure changes in such a manner that the stresses imposed by its increasing complexity are alleviated and a new equilibrium state is achieved.

The third major characteristic of the Tektology follows from Bogdanov's original statement as to the nature of the world. For him complexes are not faced by a single monolithic environment. The environment of each and every complex is comprised of all other complexes and nothing else. Each and every complex is constantly tending toward its own internal equilibrium *in a process of constant interaction* with each other complex it is in contact with and, through them, with *all* other complexes. Thus the Tektological cosmos is

constantly moving toward a myriad of local equilibria and, in this process, *actively changing* the conditions of those equilibria. Thus the cosmos does not exist as *state* but as *process*.

The Tektology demonstrates a systemic view of the world, but how does it compare to modern systems approaches? In this respect it is useful to use the "macro-paradigms"<sup>17</sup> of systems thinking introduced by Vadim Sadovsky as a basis for the comparison. Sadovsky suggests that there are two macro-paradigms which characterize the systems thinking of this century, they are *equilibrium seeking* and *non-equilibrium seeking*. Elsewhere I have argued, together with Simona Pustyl'nik<sup>18</sup>, that perhaps "single equilibrium" and "multiple equilibrium" are more appropriate, she also suggested the addition of a third, that of "self-developing systems"<sup>19</sup>, which we later developed into "co-evolutionary". Thus we have three macro-paradigms which I will argue characterize the various systemic approaches available at the present time.

The first, single equilibrium systems, in agreement with Sadovsky, is characteristic of such approaches as von Bertalanffy's GST, cybernetics, as propounded by Ashby or Wiener, or the systems engineering/analysis methodologies insofar as the systems they tend to model seek a static, or algorithmically determined series of, equilibria. The notion of single equilibrium seeking is analogous to the survival criteria implied in Bogdanov's "Conservative Selection" thus systems or complexes of this type are attempting to achieve an optimal state in these words "survival".

Systems indicative of the second type are Prigogine's "self-organizing" systems, and, from the management field, Beer's VSM and Checkland's SSM. These systems share the attribute of being able to restructure themselves in response to environmental pressures, i.e. the wider system equilibrium which tends toward

internal crises, Prigogine's in relation to thermal stimulation, Beer's in response to environmental variety and the "algedonic signal" and Checkland's through socio-cultural pressures by way of a dialectical/discursive process. Crises as a result of positive "Progressive Selection" suggest similar characteristics.

The third macro-paradigm is represented by ideas such as Lovelock's Gaia and Laszlo's "Interconnected Universe". Both these conceptions, although at grossly different levels, approach the world/cosmos as almost infinitely interconnected with each part/element/system able to affect the conditions forming the environment for all other parts. Therefore the whole forms a *super-system* with its own internal regulative mechanisms. Bogdanov's notion of "world ingression" is directly analogous to this.

In almost all of the areas systems theory has touched, the Tektology has something to contribute. Bogdanov proposed a balanced systemic theory including negative as well as positive formulations of his theories, for example the notions of de-organizedness as well as organizedness, de-assimilation as well as assimilation which give the Tektology a feeling of completeness that is lacking in some of the other approaches.

Many things have been written about the Tektology before now, some sang its praises while others have been deeply critical. It is difficult to say why this book has been largely ignored except by a "dedicated few", Gorelik's translation of the "Essays" has been available for over fifteen years and numerous articles have been published, and so a lack of access cannot be the cause. Perhaps this edition will ease its path. There is no doubt that the Tektology is a difficult book to read, my own feeling is that Bogdanov felt himself to be wrestling with concepts that were troublesome to grasp, let alone explain in accessible language. His sentences and

conceptualizations are often tortuous and liberally endowed with unfamiliar words which Bogdanov felt the need to invent in order to convey his particular meaning. The abiding impression that the Tektology left on me is of a work which, although it may contain misconceptions or plain errors, is intuitively correct and, in some places demonstrates an astounding clarity of vision and insight which borders on genius. The principles and processes outlined in the Tektology operate in all places and at all times; as such tektological complexes function in many dimensions simultaneously. Such complexes are difficult, if not impossible, to envisage as the natural tendency is to "change one variable at a time" an approach which denatures them and, by association, the Tektology. My advice to the reader is to take the time to absorb the Tektology, read it in a forgiving manner, remembering when it was written, and make the effort to envisage the implications of what Bogdanov was attempting to convey — it is an exercise that will be well rewarded.

A project of this size and complexity exacts a toll beyond those directly involved. In signing his preface to the second edition (dated November 19, 1921) Bogdanov "hails the collaborators and dedicates his book to them", it seems reasonable that I should do the same.

Hailing my collaborators — my wife Melonie and my daughters Kasenya, Ciara and Freyja — I dedicate this edition to them.

Peter Dudley  
Hull  
March 1996

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<sup>1</sup>Gorelik, G., (1975) "Principal Ideas of Bogdanov's "Tektology" // *General Systems Yearbook*, Vol. XX.

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- <sup>2</sup>Kotarbinski's Praxiology, P. Dudley (ed.) Centre for Systems Studies Press, Hull, 1995.
- <sup>3</sup>Bogdanov A. A. (1989) *Tektology: The Universal Science of Organization*, Ekonomika, Moscow.
- <sup>4</sup>Gorelik, G., (1975), "Principal Ideas of Bogdanov's "Tektology" // *General Systems Yearbook*, Vol. XX; Sadosky, (1992), *Systems Thinking on the Threshold of a Third Millennium*, *Systemist*, 14, 1; Susiluoto, A., (1982), *Origins and Development of Systems Thinking in the Soviet Union: Political and Philosophical Controversies from Bogdanov and Bukharin to Present day Revelations*, *Annales Academiae Scientiarum Fennicae Dissertationes Humanarum Litterarum*, 30; Zeleny, M., (1988), *Tectology // International Journal of General Systems.*, vol. 14
- <sup>5</sup>Dudley and Pustynnik (1995), *Reading the Tektology: Provisional Findings, Postulates and Research Directions*, Centre for Systems Studies Research Memorandum 7, Hull.
- <sup>6</sup>Bertalanffy, L. von. (1968) *General System Theory: Foundations, Development, Applications*, Braziller, N.Y.
- <sup>7</sup>Wiener, N., (1948), *Cybernetics or Control and Communication in the Animal and the Machine*, Wiley.
- Ashby, W.R. , (1956), *An Introduction to Cybernetics*, W. Clowes and Sons, London.
- <sup>9</sup>Prigogine, I., (1980), *From Being to Becoming: Time and Complexity in the Physical Sciences*, Freeman, San Francisco; Prigogine, I., and Stengers, I., (1984), *Order ut of Chaos: Mans New Dialogue with Nature*, Flamingo, London.
- <sup>10</sup>Beer, S., (1979), *The Heart of the Enterprise*, Wiley, Chichester; (1981), *The Brain of the Firm*, 2nd. ed., Wiley, Chichester; (1989) *The Viable System Model: its Provenance, Methodology and Pathology //The Viable System Model: Implications and Applications of Stafford Beer's VSM*, Espejo, R., and Harnden, R., eds., Wiley Chichester.
- <sup>11</sup>Checkland, P.B. (1981), *Systems Thinking Systems Practice*, Wiley, Chichester; Checkland, P. B., and Scholes, S., (1990), *Soft Systems Methodology in Action*, Wiley, Chichester.
- <sup>12</sup>Bogdanov, A. A. (1965), *Matter as Thing in Itself*, // *Russian Philosophy*, Vol III, Edie, J. M., Scanlan, J. P., Zeldin, M-B., eds., G. Kline trans., Quadrangle, Chicago, pp. 390-404.
- <sup>13</sup>Bogdanov shows remarkable sophistication of thought in this respect identifying in addition to the categories of organizedness the notions of "Analytical" and "Practical" sums. His argument is that in all cases the combination of elements will result in losses as per, for example, the laws of thermodynamics this calculation of activities he calls the "analytical sum". Organizedness,

the case where the whole is greater than the sum of its parts is only possible in regard to specific goals, in this case the "gain" is real in an objective sense, only in relation to the resistances that have to be overcome, this is the "practical sum".

<sup>14</sup>Vucinich, A., (1976), *Social Thought in Tsarist Russia*, University of Chicago Press, London, pp. 214/5.

<sup>15</sup>There are problems inherent in the use of the word "selection" as a translation for the Russian *podbor*, although it is widely accepted and has been used throughout this translation. Simona Pustynnik, ("Assemblage as the basis of Bogdanov's Tektology" // *Voprosy Filosofii*, No. 8, 1995 (in Russian)) suggests the term assemblage as being more appropriate, as the term selection does not adequately reflect the systemic character of Bogdanov's term *podbor*. Her argument is that this term is closer, in Bogdanov's usage, to the modern understanding of systemic evolutionism than the Darwinian sense of selection.

<sup>16</sup>Zeleny, op. cit.

<sup>17</sup>Sadovsky, op. cit.

<sup>18</sup>Dudley and Pustynnik, op. cit.

<sup>19</sup>Pustynnik, S., (1994), *Ideas of Evolution in A. Bogdanov's Tektology // The Concept of Self Organization in a Historical Perspective*, Moscow, pp. 189-198 (in Russian).



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# **Bogdanov's Tektology**

## **Book 1**

**PREFACE TO THE FIRST EDITION OF  
PART ONE<sup>1</sup>**

The founding of a science which would summarize the organizational experience of mankind, a vitally important science, is a case of great importance. Taking this initiative upon myself, I fully recognize the seriousness and responsibility of this task. Yes, responsibility: for the possible failure of the attempt, the false statement of the basic problems or the incorrectness of the first conclusions which would compromise the task for a long time, and for many years would distract the interest and attention of those, who will work over it. Nevertheless, I have resolved to do it, somebody must begin one day. Probably, others would do it better; but you would have to wait for those others... 12

This book, which is intended as the first part of a larger work, is the study of two universal organizational principles: the formative principle of ingression and the regulative principle of world selection. Circumstances of place and time allowed me to make this study only in very general form. But, I believe, even in this form it is sufficient to introduce the reader, especially the inquisitive reader, to the basic meaning and spirit of the methods of this new science.

Special effort has been made to clearly demonstrate the practical applicability, the actual usefulness and importance of this science by means of particular familiar illustrations. This is its fortunate feature: from its very beginning, tektology is able to go beyond the field of abstract cognition and assume an active role in life.

Besides, I have tried to show clearly that tektology is not something principally new; that it is an inevitable conclusion of the past, a necessary continuation of what is and has been done by people in their theory and practice, rather than a leap in scientific development. Partially, this is the justification for my audacity... if there is need of any justification.

I am most deeply convinced, that in future work I'll no longer be alone.

December 28 (15),  
1912

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<sup>1</sup>А.А. Богданов, "Всеобщая организационная наука (тектология)", Часть 1, СПб., типография М.И. Семенова, 1913, 255 стр. (A.A. Bogdanov, "Universal Organizational Science (Tektology)", Part 1, St. Petersburg, M.I. Semenov Publishing House, 1913, 255pp.) — Eds..

## **PREFACE TO THE SECOND EDITION<sup>1</sup>**

The years which have passed since the first edition have brought a lot of new material; some new conclusions were formulated, and the old ones made more precise, although essentially I still do not deny anything of importance. I became less and less satisfied with the order of exposition, which originally followed the line, so to say, of least resistance, i.e. beginning with what had already been prepared by scientific development and then going to less traditional conceptions, rather than being guided by the needs of logical consistency. It had to be reconstructed. Partially, this was done in a series of papers under the title "Essays on organizational science", published by the magazine "Proletarskaya kultura" in 1919-1921, N. 7-20<sup>2</sup>. However, the conditions of publication forced me to abridge the material significantly. The present edition takes the basic architecture of the "Essays" and contains, as far as possible, all the old materials and, partially, some new ideas — although, regrettably, not all of them, as some were not in my possession: this was prevented by the scarcity of time and forces, but I could not postpone it any longer, as the first edition has become a bibliographical rarity, and even the magazine with the "Essays" was available only to a small number of those who were interested.

The main modification of the architecture of the book is that the formative mechanism now goes before the regulative one, as is demanded by logic; besides, the general exposition of both mechanisms precedes their more detailed study.

There are also some modifications of terminology. The expression "conjugal sum", which insufficiently expressed the idea of the adding of activities, mentally extracted by analysis from an integral

complex, was substituted by the more exact expression "analytical sum". The notion of "copulation" was eliminated as unnecessary, etc.

The third, new part of the work embraces the theory of crises and organizational dialectics. It completes the exposition of *general* organizational theory as I came to understand it. It should be further followed by particular studies of the theory's application to several branches of science, which would be deeply reformed by it. Two such studies, one dealing with the social sciences, and the other — with psychology, I have already almost prepared. The first one is even partially published. In fact, I consistently applied tektological methods, while not using this word, in a number of works devoted to the problems of economics and the development of ideologies; especially in three textbooks of political economy<sup>3</sup> — "Introductory", "Short Course" and the larger "Course", the latter being written in collaboration with I. Stepanov, where I was responsible for the theoretical and methodological sections, and "The Science of Social Consciousness"<sup>4</sup>. In a public presentation to the Academy I outlined the application of this view to the theory of the development of social technology, etc. In this area I need only to combine integrally the elements, which are already prepared. But, according to my plan, all this should be introduced into a new cycle of studies, based on the present work, and which I hope to make in collaboration with other people.

While nine years ago my attempt seemed to be ideologically untimely, now the situation has significantly changed. The years, which have passed, years of great de-organization, as well as of great organizational efforts, stimulated all around the world a need for a scientific formulation of organizational problems. Particular applied sciences of this type are now developed — those of the organization of workshops, of enterprises in general, of the army... The insufficiency and shaky empiricism of these attempts make the

necessity of the broader task even more strongly felt, although there is still a lack of understanding of its general character and the universality of its regularities...

Fortunately, apparently we don't need to wait for Europeans to do, independently, that which is already being done. At least in Russia I can happily state that my hope to be joined by adherents and collaborators is at last realized. A number of young — and even not so young — scientists have definitely chosen the way of tektological research, applying its methods and more securely established conclusions to the different vital problems of practice and science: those of the planning of the national economy, educational programmes and modes, the analysis of transitional economic forms, socio-psychological types, etc. The number of published results is not sufficient yet, but the work is going on — vital, persistent, and staunch work.

Hailing the collaborators, I dedicate to them this book.

November 19, 1921. Moscow

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<sup>1</sup>The second edition of "Tektology" was printed in Berlin by Grjebin Publishing House in 1922, it included the first two parts and the newly written third. (A.A. Богданов, "Тектология: Всеобщая организационная наука", Части 1 и 2, 2-ое издание, заново переработанное и дополненное; Часть 3, 1-ое издание, Берлин — Петербург — Москва, Издательство З.И. Гржебина, 1922, 530 стр. (A. A. *Bogdanov*, "Tektology: Universal Organizational Science". Parts 1 and 2, second edition, revised and newly written part 3, first edition. Berlin, Petersburg, Moscow, Z.I. Grjebin, Publishing House, 1922, 530 p.) "The conditions of the publishing house, but not the author, were such that only a small part of the edition could be distributed



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on the Russian bookmarket", (Bogdanov's footnote, published in the third edition of "Tektology" in 1925) — Eds..

<sup>2</sup>А.А. Богданов, "Очерки организационной науки" // Пролетарская культура Москва 1919, № 7 - 8 стр. 8 - 29; № 9 - 10 стр. 5 - 20; № 11 - 12 стр. 10 - 26; стр. № 13 - 14 стр. 16 - 43; № 15 - 16 стр. 6 - 38; № 17 - 19 стр. 6 - 32; 1921; № 20 - 21 стр. 3 - 19. In 1921 Bogdanov published these papers in book form as: А.А. Богданов, "Очерки всеобщей организационной науки", Самара, Госиздат, 1921, 332 стр. (А.А. Bogdanov, "Essays on a Universal Organizational Science", Samara, Gosizdat 1921, 332 p.) For an English translation see G. *Gorelik*, (1984), "Essays in Tektology: The General Science of Organization" (2nd. ed.), Intersystems — Eds.

<sup>3</sup>А. *Yassour*, in his bibliography "Bogdanov et son Oeuvre"(Colloque International Sciences Sociales, Paris, 1964, pp. 546 - 584) identifies these books as "Краткий курс политической экономии", (short) Moscow 1897; "Курс политической экономии", with E. *Stepanov*, (course) St. Petersburg, 1910; "Введение в политическую экономии", (introduction) St. Petersburg, 1914. In the English translation of the "Short Course" ("A Short Course of Economic Science", J. Fineberg (trans.), CPGB, London, 1923) Bogdanov, in his 1919 preface to the tenth (revised Russian) edition calls them the "Short Course" the "Course" and "A First Course" respectively. The later, Biggart, Glovelli and Yassour (Alexander Alexandrovich Bogdanov: A Bibliography, Professional Training International, Norwich, 1995), confirms these details — Eds.

<sup>4</sup>А.А. Богданов, "Наука об общественном сознании: Краткий курс идеологической науки в вопросах и ответах", Москва Книжное издательство писателей, 1914, 199 стр. (А.А. Bogdanov, "The Science of Social Consciousness: a Short Course in Ideological Science in Questions and Answers", Moscow, Writers Publishing House, 1914, 199 p.).

**AUTHOR'S NOTE TO THE THIRD EDITION OF  
PART ONE<sup>1</sup>**

I do not give any special preface to this edition; instead, I provide the preface, which was written for the German translation of this book and, I believe, sufficiently illuminates its task.

As regards several remarks concerning the criticism of this book, which have appeared by now, I felt that it would be reasonable to place them at the end of the book, in the form of addenda.

September 24, 1924

*A. Bogdanov*

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<sup>1</sup>*A. Bogdanov*, "Universal Organizational Science, (Tektology)" Part 1. Third edition further revised and augmented. Leningrad - Moscow, "Kniga" Publishing House, 1925, 300p. — Eds..

**PREFACE TO THE GERMAN TRANSLATION<sup>1</sup>**

All scientific experience persuades us that the possibility and probability of the successful resolution of problems increases, when

they are stated in *general* form. If the problem of calculating the distance, say, from the Earth to the Moon was stated as an independent question, it surely would not be resolved even now. However the incommensurably more general problem — of the distance of an inaccessible object — was resolved many centuries ago, and simultaneously, the method was worked out for the resolution of this particular problem, and it became, in principle, solvable. When the tyrant Hieron ordered Archimedes to check the composition of his crown, as he suspected that a part of the gold given to the jeweller for it had been substituted with silver, the super-genius of Archimedes would be impotent, unless his thinking went beyond the data of the immediate problem. He replaced it with another problem, which was general and unrelated to the particular data — of the determination of the specific weight of bodies of any form, and, by its resolution, had the opportunity to resolve not only the specific problem, which had been put forward, but also innumerable similar problems. Likewise the huge cognitive and practical power of mathematics rests upon the extremely general statement of problems.

All this is quite natural. Generalization is at the same time *simplification*. The problem is reduced to the minimum number of the most recurrent elements; numerous complicating points are extracted and discarded; certainly, the task is thus facilitated; and, constructed in this form, transition to the more specific task is carried out by the reverse inclusion of discarded particular data.

So we come to the question of the *universally generalized* formulation of problems. This is *our* formulation.

It should embrace all real and possible problems — both *theoretical and practical*. Here lies the difference from all previous views, not only with special scientific views, but also with so called "philosophical" views in the broadest sense of the term.

Philosophy aspired to the universal explanation of all existence, to the universal guidance of life. These were tasks of a universal character, but they did not contain the idea of a universally generalizing method, which would embrace both general and particular tasks. It did not appear even when philosophy began to acquire a methodological character and take on the appearance of "epistemology" or even "general methodology". It was always assumed, that theory and practice differ in their *methods* and, in that, could not be reduced to unity.

However, in Hegel's dialectics an obscurely expressed tendency toward such reduction may perhaps be discerned. For Hegel, dialectics is the universal method of the effective self-development of the Weltgeist, which is its "Praxis" and at the same time its self-reflection. But certainly neither Hegel, nor the Hegelians, considered dialectics as the instrument of the resolution of the immediate, vital practical problems of, for example, technology, economy or daily life; it had to elucidate and sanction real solutions, rather than serve as a direct approach to them. Even materialist dialectics — in general and in total — adopts a predominantly explanatory position; but for social struggle, in Marx's theory, it has assumed, to a certain extent, a directive and practical character: for the acceleration of development, it is necessary to maintain and reinforce its real contradictions, by recognizing them and spreading this recognition among the class collective, organizationally arranging these within

the collective. However, even here the dialectics of objective development does not play a similar role, for example, to that of mathematics, the instrument of planned study and the resolution of problems; at best, a solution arrived at by traditional, particular methods, is subsumed under the dialectic scheme.

But is a truly universal formulation of problems possible? If we draw them from such heterogeneous spheres, as, for example, technology and law, elementary arithmetic and philosophy, formal logic and art — what common ground is left, other than that they are — "problems"?

This is the point of the matter. Thorough research shows that the concept of "problem" conceals much more than is understood by ordinary thinking. All problems can and should be understood as *organizational* this is their universal and constant meaning. Let us reveal their basic features.

Whatever the nature of a practical, cognitive, or aesthetic problem might be, it is always comprised of a certain sum of *elements*, its "data"; and its formulation depends upon the fact that the actual combination of these elements is unsatisfactory to some person or collective, which in this case is the acting agent. The "solution" consists of a new combination of elements, which "corresponds to the needs" of the resolving agent, which is "expedient" for him. But the concepts of "correspondence" and "expediency" are wholly *organizational*; and therefore express some heightened or improved correlations, similar to those, which depict organisms and organizations; "more organizational" correlations, from the point of view of the agent, than those which existed before.

This explanation concerns unconditionally all actual and possible problems. If we should build a house — it is possible only due to the availability of indispensable elements, such as wood, stone,

lime, glass, axes, saws, hammers and other instruments, the working forces of carpenters, stone-masons, etc.; and this is possible only by their connexion and disconnexion, by combining them anew; and the outcome — a building — is characterized by such connexions and correlations of its elements, that it contains something more than it had initially, that is, an improved harmony between people and their physical environment, and therefore it represents, from the point of view of people, an "organized" system. If we should organize an enterprise, a detachment or an institution — human, technological and ideological elements must be available; and the task is their consecutive combination until a new organized whole appears. If we create a scientific explanation of a series of obscure facts or artistic expressions and elucidations of exciting moments in life — again we have to combine selectively the elements, observed in reality, in previously arranged mental activities, in the emotional vibrations of a creative soul — as well as material and technical elements, such as paper, paints, marble, pen, brush, chisel. And the outcome is again organizedness, which is called "proper proportion", "truth", "aesthetic harmony", etc. The primary commensurability and homogeneity of all organizing processes have been felt by people long before now; Alfred de Vigny in his novel "Stello" has already said that "sometimes it is easier to organize a great government, than a little book". And not without reason, at the dawn of cultural thought people saw an organizing will behind all processes in nature and life. And now, not without reason, the application of organizational concepts to practice and science becomes continually more and more broad, apparently drawn towards universality.

But, we might be asked, what is the use of this universalization? What is the contribution to the actual substance of problems and how can their solutions be facilitated, if we understand that all of them are organizational? My answer is: it is the ability to

consciously create general formulations of problems which gives us the ability to consciously create a general approach ; it is the first stage of the elaboration of *universal methods for their solution*.

Human life and the life of a collective is a chain of formulations of, and solutions to, problems. The main and most oppressive difficulty here consists in their tremendous *heterogeneity*.

A woman, with her ordinary lot: housewife, wife and mother. In the kitchen she faces different problems of a technical character, in furnishing and maintaining the apartment — a number of problems, which are also technical, but of an absolutely different type. Shopping, budgeting, and sometimes domestic staff oblige her to resolve many frequently very complex "economic" issues. Relationships with her husband and children, family life with its inevitable contradictions bring very difficult social and daily problems, which sometimes become absolutely insoluble with the elements and forces available to her. The upbringing and education of her children are sanitational, medical and pedagogic tasks — the latter being of a large scale and diversity, all with their ideological basis. And everywhere specific approaches, particular experience and knowledge, specialized methods are implied. What a universal genius this poor being needs to be to manage all of these truly successfully! And if her spouse — usually also her exploiter and sovereign — can, at her expense, hold a narrower ground, the very problems of "procuring a living" and the "struggle for life" because of their acute standing, their complexity and obscurity, often to the level of the indefinability of data, frequently far exceed hers.

Of course, all-embracing experience and genius in practice are substituted by tradition and routine. This substitution can be to a certain extent sufficient in calm, "organic" times, when life more or

less stereotypically reproduces not only types, but even specific forms of current urgent problems. But in transitional, especially revolutionary times, things are different. Suffice to conceive, how different and unsteady after the First World War the whole standing of the problems of family economy became even in comparatively prosperous countries, to say nothing of Germany, Austria and Russia.

But these are little problems of trivial, everyday life. And those, which our age puts before collectives, groups, classes and organizations, of their struggle and development are extremely confused, complex, unprecedented, with no more or less appropriate past experience. And there is one predominant task, embracing and recapitulating all of them. The First World War and the World Revolution have clearly put the dilemma: overcome the anarchy of social forces or face the collapse of civilization. This is the problem of death or life, demanding an all-organizational solution. Ideal technological organization is useless or even pernicious, when economic forces are unruly and entice nations into mad, annihilating conflicts; and it is impossible to achieve order and harmony in the economy, while public consciousness, bound by past prejudices, moves in incompatible and contradictory directions. The way out of this is in the unified organization of things, people and ideas, which would bind together the elements of each row and at the same time all these three rows dynamically and harmoniously. It is clear, that this single problem includes and embraces a great number of partial tasks, which for contemporary thinking are most heterogeneous in their character.

This diversity and heterogeneity of tasks in the present state of organizational experience and knowledge implies specialized, differentiated approaches. This is a major and tremendous difficulty not only for the individual — we have already talked about it — but



also for the collective, even if it is a powerful social class. It may appear, that the members of a collective, by means of specialization in different tasks, which are the parts of the integral task, can cope with them; but an integral solution cannot be thus achieved. The fact is that specialization itself undermines the collective homogeneity, gives birth to separateness, mutual misunderstanding, and then to contradictions between its differentiated elements; then the collective becomes disjointed in its life and its activity, and is unable to work out a singular, integral structure for the whole society. This is what had happened with the bourgeoisie: it failed to become an actual collective and to create any organization, other than anarchic. And as the proletariat submits to the specializing forces of bourgeois culture, it also is subject to similar separateness leading to direct contradictions. Thus its trained upper strata and unskilled lower strata are separated, reflected in the two Internationals of our time, one being opportunistic, and the other — revolutionary<sup>2</sup>; and along with it — "corporative" trends in professional movements, divergence in the programs and tactics of trade unions, worker's co-operatives and worker's parties, etc. Even if the objective social and economic tendencies are toward the overcoming of this separateness, the lack of unity of organizational thinking will be a constant obstacle on this path and the obsolete forms of specialized thought will not be defeated here either.

This makes evident the need for universal and general organizational methods, which would put an end to the anarchic split of organizational experience. Certainly, the problem is whether it is possible and can be achieved even now. My work not only gives a positive answer to that, but also provides the starting point for the process.

The point of departure is the progressive universalization of methods, which has developed in scientific technology and science since the appearance of machine production.

The method of machine production everywhere is fundamentally the same: this is the utilization of energies by the planned transformation of some of their forms into others; and this is true not only for natural energies, but also for human labour, which can substitute them or be substituted by them. And, being precisely formulated by science, this transformation of energy provided a universal methodological outlook for physics and chemistry; and then the "energetic method" spread into other sciences, as they are based on physics and chemistry and submit to their influence. Biological sciences have been firmly on this path; the social sciences, which are less developed and precise due to the complexity of their object and a number of obscuring social and ideological circumstances, nevertheless begin to take this path, being assisted by their convergence with biology. Thus, theoretical universalization reflects and continues practical universalization.

However, "energetism", which has provided us with a unified conception of world material — "activities-resistances" — is not our only point of departure. The principle of "selection" ("отбора") step by step acquires an equally universal character, passing from biology to physics and chemistry, on the one hand, and to the social sciences, on the other. And ever more resolutely the idea of the *unity of mechanisms* works its way into the most heterogeneous groups of phenomena, even in different "kingdoms of nature".

For example, the universality of the "equilibrium" mechanism was assumed long ago; it has not once been claimed, that the law of Le Chatalier is applicable not only to physics and chemistry, but to sciences about life, the psyche and society as well. George Darwin,

worthy son of the great father, apropos the theory of tides and origin of double stars, already in 1905-1907 tried to give a general scheme of conservation and violation of equilibrium, which would apply to all forms of being — from astronomical to social systems. The Serbian-French scientist M. Petrovitch already in 1906 tried to justify the "doctrine of analogies" by working out formulae of "general mechanisms of heterogeneous phenomena"<sup>3</sup>. And the same unifying tendency is contained in Einstein's principle of relativity, which is its most attractive feature for advanced thought, although far from being the main reason for its present "fashionability".

All these monistic factors of the modern development of methods need, in their turn, to be reduced to the unity of a point of view which would embrace and generalize all of them into a harmonious concordance. And this can be done only from an *organizational point of view*. I gave its formulation and basic applications in the first edition of this book (1913).

Being alien in its universality to the predominant type of contemporary thinking, educated in specialization, on the one hand, and social and economic anarchy, on the other, it isn't lightly received by the majority, and this hardly prepares the path for universality. But this is the way things go, and, by touch, they are felt from many directions. Its germs are contained in the partially organizational applied sciences, developed during recent decades: those of the organization of workshops of craftsmen (мастерская), of enterprises, of institutions in general, of the "psycho-technics" of working forces, etc. There are indications of the transition towards a broader, theoretical formulation of this point of view of which I now give an example. Professor J. Plenge from Munich, who holds a position infinitely distant from mine, under the impression of an enormous de-organization of life along with a huge diversity in the attempts to organize it, came in 1918 to the idea of the necessity of a

"Universal organizational science" (see his booklet, which contains three lectures he had read in Muenster University<sup>4</sup>). And although he means by this only the science of human organizations, studied only within the framework of their planned functioning, he has, in his attempt of a general approach to the problem (he hasn't gone further), indeliberately gone astray towards broader ideas, at least in the fields of biology and its theory of organisms.

Of course, these are only hints. You cannot expect more from those who represent the old world. But even for the more advanced elements of life, this new point of view seems to be unusual and difficult to understand. In the unprecedented conditions of present day Russia, with its terrible devastation and most strenuous organizational efforts, stimuli for its reception are more powerful than ever. Nevertheless, it has met huge passive and sometimes active resistance. However, it begins to capture its place in life; it has not only proponents, but also active promoters, and the number of them increases.

October 22, 1923

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<sup>1</sup>A. *Bogdanov*, "Allgemeine Organisationslehre (Tektologie)", Autorisierte Uebersetzung von S. Alexander und Rud. Lang, 1 Band, S. Hirzel, Berlin, 1926, 213 p, 2 Band was published by same publishing house, S. Hirzel, Berlin 1928, 199 p. — Eds..

<sup>2</sup>Bogdanov is speaking of the 2nd International and the Communist International (Komintern) —Eds..

<sup>3</sup>M. *Petrovitch*, "Mecanismes communs aux phenomenes disparates", Paris, Nouvelle Collection Scientifique, 1921.

<sup>4</sup>J. *Plenge*, "Drei Vortrage ueber allgemeine Organisationslehre", Muenster, 1918 ("Three Lectures on Universal Organizational Science") — Eds..

# Part One

# Chapter 1

## Introduction

### The Historical Necessity and the Scientific Feasibility of Tektology

#### §1. The Organizational Point of View

1.

*All human activities are essentially either organizational or de-organizational.* This means that human activity, be it technical, social cognitive, or aesthetic, may be regarded as the material of *organizational experience*, and investigated from the organizational point of view.

In lay discourse, the terms "to organize", "organization", or "organizational activity" have a specific, narrow meaning. However, to give our concepts scientific exactness and certainty, we must dismiss this lay usage as vague and inconsistent.

Most often the term "to organize" is used when somebody is speaking about people, their labour, and their efforts. "To organize an enterprise", "to organize an army" or "campaign", "to organize defence", "attack", "research" and so on is to collect people for some purpose, to regulate and co-ordinate their efforts in the light of

some rational unity. But if we were to cast a closer eye over one of these cases, say, on the most typical, the organization of an enterprise, we would immediately find that even there the concept of organization covers wider territory than just human activity.

The organizer of an enterprise collects people and combines their labour actions. In many cases these actions may be *replaced* by the work of mechanisms. When a mechanism is *introduced*, the task of the organizer becomes to co-ordinate, or to co-organize *the actions of workers and the work of mechanisms* expediently. The *organized entities* are comprised of both living and non-living activities.

However, a mechanism is just one of many *instruments*, although it may be more complex than others. Technical instruments extend bodily organs, the organizing elements of working power; so that the improvement of an old instrument or the introduction of a new one demands a regrouping of working power, or modification of the interaction of working actions. The same, to some extent, can be said about other means of production. Therefore, the task is to co-organize working power and the means of production into a system, functioning according to a plan — the organization of *people and things into a rational unity.*

When an inventor is trying to construct a mechanism by combining and organizing its elements with a definite purpose in mind, these elements are things with specific energies: thus a "dead" machine may also be considered as an organized system, although it may contradict common sense.

Generally, the whole process of human struggle with nature, of the conquest and exploitation of spontaneous natural forces, is nothing other than the process of organizing the world for humanity, for its survival and development. This is the meaning, the objective sense of human work.

The organizational character of cognition and of thought in general is even more evident. Cognition co-ordinates the facts of experience into internally consistent groupings — thoughts and systems of thoughts, i.e. theories, doctrines, sciences, etc.; in other words, its function is to organize our experience. The exact sciences are organizing the modern technologies of machine production; and they are able to do it only because they themselves are organized past experience — which for the most part is as technical as they are themselves.

The principles of works of art are agreement and harmony, and therefore organization. Art, combined and often alloyed with cognition, as may be seen in many pieces of literature, poetry and painting, organizes human images, feelings and emotions. In art the organization of ideas and the organization of things are inseparable. For instance, an architectural construction, a monument, or a picture as they are, might be regarded as systems of "dead" elements — of stone, metal, canvases and paint; but the lively meanings of pieces of art belong to the complexes of images and emotions to which they give life in a human psyche.

We see that human activity from its simplest to its most complex forms might be reduced to organizing processes. And yet we are left with destructive activity. On direct and isolated consideration its function is *de-organizing*. However, a deeper analysis shows that even this form is an outcome of competition between different *organizing* processes. When a man is killing and eating an animal, he de-organizes some living system to organize its elements according to his physical constitution. When he is killing predators, he does this because they represent a de-organizing force for him; and, by removing them, he organizes his own living environment according to his interests. If societies, classes, or groups interact destructively and de-organize each other, the very reason for it is that each of



these collectives desires to *organize* the world and mankind in accordance with its own purpose. This is an outcome of the separateness and isolation of organizing forces, an outcome which prevents us from achieving this unity and common harmonious organization. It is a *struggle between organizational forms*.

This general scheme shows us the whole content of the life of mankind, and now we can draw some conclusions. The old teacher of scientific socialism, F. Engels, expressed them in this formula: production of people, production of things and production of ideas. The word "production" conceals the concept of organizational activity, and we will make this formula only more exact by saying: *organization of external natural forces, organization of human forces and organization of experience*.

So what have we discovered? Mankind has no task and no activity, other than the organizational.

All the interests of mankind are organizational. From this it follows that there cannot be, and there should not be, any other view of life and the world, than the organizational one. And that this is still not properly understood is due to a remaining fetishism distorting the process of the intellectual development of mankind.

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So far, so good: we, people, are organizers of nature, of ourselves, and of our experience; we can look at our practice, cognition and creativity from the organizational point of view. But what of nature — is it an organizer? Would it not be a naive subjectivism or poetic fantasy to apply the same view to its events and actions?

nature  
crystal

## Chapter 1, Introduction

Nature is the *first* and the greatest organizer; and a human being is only one of its organized creations. The simplest living cell, observable only when magnified a thousand times by a microscope, far exceeds everything that man is able to organize in terms of the complexity and perfection of its organization. Man is just the student of nature, and so far a poor one. 2

But if all living phenomena may be investigated and understood as organizational processes, do we not have besides the vast area of the "non-organic" world, of dead nature, which is not organized? Certainly life is a minuscule part of the Universe, lost in the ocean of infinity; but non-living, "non-organic" does not mean non-organized. Until recent times the organizational weakness of human thought has been the reason for its being predominated by this old error; now these times are coming to their end.

Science is now destroying the impassable borders and closing the gap between living and non-living nature. The world of crystals has shown properties typical of organized bodies, which before had been considered as characteristic only of the realm of life: crystallic bodies are able to preserve their form in a saturated solution by means of the exchange of substances; when damaged, they re-establish it, as if "healing an injury", under conditions of overcondensation; they "reproduce" themselves, etc. However, crystals are not the most complicated of non-organic complexes; and the links between the realm of crystals and the rest of the non-organic world are such that there can be no way of talking of some principal, unconditional difference. Among liquids there are complexes — so called "liquid crystals" — which possess the *majority* of crystallic properties. And Lemann's "apparently living crystals", produced under certain temperatures from dinitro-oxibrown ethyl ether, are capable not only of reproducing themselves by division and of "copulation", i.e. fusion into pairs, but

also of eating and growing, taking food inside, and of moving like amoeba; these crystals have all the essential properties we usually expect from the simplest unicellular micro-organisms.

Even an ordinary drop of dew on a leaf in condensed atmospheric vapour grows and is reproduced by division: upon reaching a particular size, it is divided into a pair of drops; and each of them, also growing in condensed vapour, can reach the original size and continue the process of reproduction. And its surface, physically similar to an elastic pellicle, "preserves" its form like the thin resilient surfaces of many living cells, for instance, bacteria.

It would be strange to recognize a particular organizedness in crystals and at the same time to call "non-organized" the harmonious, enormously stable, billions of years old systems of suns and their planets. But for contemporary theory the same is true of the structure of every atom, with its amazing stability, based on the immeasurably more rapid, cyclic movements of its elements, the electrical activities.

Complete de-organizedness is a meaningless concept. Essentially it is the same as naked non-being. In accepting it, we must recognize the absence of any connexions; but that which has no connexions offers no resistance to our efforts, and it is by this resistance we know of the being of things; therefore, for us there can be no being here. We can only talk about complete unrelatedness; but no real, living image can be put into these words because the absolutely unrelated image is not an image at all, and therefore it is nothing.

Even the apparent emptiness of empty space, of the universal ether, does not lack elementary organizedness; this organizedness engendering a resistance; a moving object can go through it only at a limited speed; and when this speed grows, then, according to

contemporary mechanics, resistance is also growing — at the beginning imperceptibly slowly, and then more and more rapidly; and, reaching the limit, which is equal to the speed of light, it becomes absolutely irresistible, infinitely great.

Common thinking accepts this view implicitly by calling these non-organic complexes "the systems", thus expressing the idea of the organized whole, and by applying to them the concept of "destruction" which would be completely meaningless when applied to something completely non-organized.

Therefore, beyond the limits of life there exist ever *lower* types and levels of organization: the absolute absence of organization cannot be comprehended without contradiction.

In technics, we have found the organization of things for human purpose; now we find it in nature without reference to human goals. In its turn, all of nature becomes the field of organizational experience.

So the facts and ideas of contemporary science inevitably lead us to a uniquely holistic and uniquely monistic understanding of the Universe. This universe displays an infinitely unfolding canvas of forms, of different types and levels of organizedness — from the unknown elements of the ether to human collectives and systems of stars. All these forms, in their mutual relatedness and struggle, and its constant changes, constitute the organizational process of the world, infinitely split in its parts, but continuous and unbreakable as a whole. So, the area of organizational experience coincides with the area of experience in general. Organizational experience is all experience regarded from the organizational point of view, i.e. as the world of organizational and de-organizational processes.

## §2. The Unity of Organizational Methods

So this is the organizational point of view. It is absolutely simple and irrevocable in its simplicity. What does it give us, and what prospects does it show?

It would be little of use for theory and practice, if we were to confine ourselves just to the philosophical statement that "everything is organization". For theory and practice, *methods* are what are necessary and important. With respect to them, the implication is obvious: "all methods are organizational". So the task is to understand and investigate all methods as organizational. It may be a big advance, but only if one condition is fulfilled: organizational methods should be amenable to scientific generalization.

If, in one area, organizational methods are of one kind, in a second — of another, and absolutely different kind, and in a third — of some other, as it is in the case of the organization of things, or technology, which has nothing in common with the methods of organization of people or economies, or methods of organization of experience, that is, the world of ideas, it would not be any easier for us to grasp them if we were to designate them as organizational. It would be another matter if our research were to show that they have a kinship or connexion and that they can be submitted to general laws. Then the investigation of those connexions and laws would allow people to master and systematically develop these methods and thus become a powerful instrument of every theory and practice. So which, the first or the second, actually is the case?

The most profound distinction that we know in nature is that between spontaneity and consciousness, between the blind actions of natural forces and systematic human efforts. Here we can expect the

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greatest heterogeneity of methods and their irreducibility to a unity. Here is the best place to start our research.

First of all we come across the fact of people's *imitation* of nature in their means and methods of organizational activity.

Nature organizes the resistance of living organisms to cold by furnishing them with fluffy fur, feathers or other cold-resistant covers. People achieve the same results in a similar way by sewing warm coats. Spontaneous development in fishes adapted them to swimming in water by giving them certain forms and physical constitutions. People give the same form to their boats and ships by reproducing the skeletons of fish: the keel and frame of a ship perfectly correspond to a fish's spine and ribs. The seeds of some plants and animals with flying membranes move by means of a "sail"; people adopted the method of sail and applied it broadly throughout history. The knives and spears of primitive savages probably imitated the natural cutting and thrusting weapons of animals, for example, the fangs and claws of predators. In the history of humanity we can find as many illustrations like these as we like.

The capacity for imitation itself is a sufficient proof that there is no principal, insurmountable difference between the spontaneously organized work of nature and the conscious and systematic actions of people. This is a sufficient proof of the *principal homogeneity* of the organizational functions of man and nature: an imbecile cannot imitate the art of genius, a fish — the eloquence of an orator, a crayfish — the flight of a swan; imitation is impossible where there is nothing in common. But even more evident and convincing is this basic similarity where a man, *without imitating* nature, invents organizational adjustments which can later be found in it by cognition.

The history of anatomy and physiology is full of discoveries of such adjustments in living bodies from the simplest to the most complex, which before their discovery in these fields had been invented by people independently. For example, the skeleton of the human cranial apparatus is a system of various levers, which, in particular, contains two blocks (one for jugular and the other for eye muscles). But levers had been used by people for weight-lifting thousands of years before this anatomical discovery, and blocks — for many hundreds of years. Suction and force pumps with valves had been constructed long before the discovery of quite similar mechanisms in the heart apparatus. The same is true of musical instruments with resonators and vibrating membranes, which had been invented long before we found out about the constitution and functions of animal vocal organs; and it is equally highly improbable that the first magnifying glasses had been made to imitate crystalline lenses<sup>1</sup>. And the construction of the electrical organs of some fish was studied long after physicists had constructed condenser batteries, based on the same principle.

These are the first striking illustrations taken from one limited area, which could provide us with many more. But here is a comparison of another kind: the social economy of men and of higher insects. Certainly, the assumption that they had imitated each other, is out of the question. However, there is a striking parallel between their modes of production and forms of co-operation. The construction of complex, ramified dwellings by termites and ants, the breeding of livestock by some ants, which keep plant-lice as milch cattle, are well-known facts; it has been found that some species of American ants have incipient land cultivation: they weed out grasses from around edible cereals; probably, people also had started to cultivate land in this manner. It is also firmly established, that Brazilian leaf-gnawing ants plant edible fungi in their ant-hills. Close co-operation

and complex division of labour amongst *social* insects is very well-known; however, their division of labour is generally "physiological", that is, it depends on the special constitution of the organisms in different groups — workers, warriors, etc.; but, it should be noted, that the division of labour between people was, initially, also physiological, i.e. based on differences of male, female, immature and senile organisms. The general character of the organization of ants is tribal matriarchy, with the mother representing neither instructorship for work nor power in the community, but its living consanguinity; there are many reasons to assume that the role of the original mother in primitive forms of human matriarchy was the same. It has been observed, that ants are subject to phenomena analogous to human social vices, particularly, to alcoholism. Some ant-hills give shelter to guest-beetles, *Atemeles*, *Lomechusa* and others, which are kept and nourished by their hosts for their pleasant etherous secretions. The results are analogous to those for people: partial, and sometimes complete, degradation of whole ant-hills.

This is organizational and cultural parallelism, developed independently by both sides: it cannot be doubted that the common ancestors of both people and insects were not social animals.

Even more remarkable are the coincidences observed in the biological sphere, amongst the most distant and independently developed species.

The means of reproduction of higher animals and of flowers with their complex sexual divergence show immense parallelism, although it can assuredly be claimed that the unicellular proto-organisms, from which these two branches of the realm of life have separated, did not possess such means; there could be only a simple population of cells of one kind. Therefore, this sexual divergence,



that is, the method of production of new combinations of vital properties, had developed independently in both cases. No less remarkable is another and only recently discovered parallelism of the nervous and muscular systems of multi-cellular organisms with a similar apparatus in higher uni-cellular infusoria: fibres-conductors and contractors in the former correspond to the brain centre of the latter. Here also we cannot suspect the existence of common ancestry.

As has been firmly established, higher orders of mammals could not have descended from corresponding groups of marsupials. Nevertheless, there is a striking parallelism of their ways of life, constitution, and even physical appearance. It would suffice just to compare marsupial wolves, rodents and insectivores with similar species of higher mammals.

So, the means of spontaneous organization in nature and the methods of conscious organizational work of men, separately as well as in conjunction, can and should be subject to scientific generalizations. However, old thinking has made "impassable" the borders not only along this line, but also established a number of other "absolute", essential distinctions. One of them, that is, between "living" and "dead" nature, we have already considered, and it turned out, that from the organizational point of view it is by no means "impassable", that it merely reflects differences in levels of organizedness. And we observed wholly parallel organizational combinations on both facets of this dichotomy: there were "metabolism", "reproduction" and the "healing of injuries" in the non-organic world, etc. It is possible to give other striking illustrations of this basic homogeneity. Planetary systems on one level of non-organic forms, and the structure of the atom as it is conceived by modern science, on the other, represent a characteristically *centralistic* type: a "central" complex, i.e. the Sun

or the positively charged nucleus of the atom, is generally determinant of the movements and correlations of the other parts and the whole. In the realm of life the centralistic type is one of the most common; it is sufficient to mention the role of the brain for animal organisms, of rulers — for authoritarian societies, of queens — for bees and ants, etc. Another very widely spread type is the combination of solid, or elastic, but physically more stable membranes, with liquid, more mobile or less stable contents. This is, probably, the form of equilibrium for the majority of planetary systems and even for a drop of water, with its surface stratum serving as membrane; but this is also a common structure for vegetable and, frequently, animal cells, and for a great number of organisms, who "wear" an external skeleton.

Turning to an even larger scale, we find the most widely spread natural method of conservation or re-establishment of equilibrium, i.e. periodical oscillations or "waves". It can be said to be the general model for innumerable processes in the non-organic world, both the ones which are observed directly, and for those which are adopted by science owing to their theoretical necessity: water waves, sound vibrations in air, thermal vibrations of solid bodies, electric<sup>2</sup>, both light and "invisible", waves — from Hertz's frequencies to X-rays; and on the other pole of the Universe, the "revolutions" of celestial bodies can be represented as complex periodical oscillations... But this model is applicable without limit to the realm of life: almost all of its processes have periodically oscillating characteristics. Such are pulse and breath, work and rest in every organ, wakefulness and sleep in the organism. Changes of generations are a series of superimposed waves — a genuine "pulse of life" across the centuries, etc.

The majority of philosophers and a significant number of psychologists even now adopt one more "impassable border":

between "material" and "spiritual" natures, or between "physical" and "mental" phenomena. Here they could also assume the absolute irreducibility to unity of organizational methods. However, the same philosophers and psychologists recognize, although in different degrees and under various names, a certain parallelism of mental phenomena with physical nervous processes. But parallelism means exactly that the relations of elements and combinations on one side correspond to those on the other, i.e. that there is basic unity of the means of organization. Would it be possible for a "mental image", perception or idea, to correspond to a "physical object", if the parts of the former were not combined in the same order as the parts of the latter? And, for example, the abovementioned oscillating rhythm of work and rest, peculiar to the physical processes of organisms, is observed, in parallel, in mental phenomena; and frequently it is observed in the mental sphere, while it cannot be as clearly established for physiological processes, as, for example, in the case of "attention waves". And any product of "mental creation" — scientific theory, piece of poetry, system of legal or ethical norms — has its *architecture* and representative differentiated totality of parts, which perform different functions and complement each other. This principle of organization is the same as for the physiological organism.

Not only laymen, but even the majority of professional scientists, striking upon enormous similarities in the correlations of the most different and distant spheres of experience, rest themselves with the formula: "they are just simple analogies and no more". This is a childish and naive opinion; it abandons the issue exactly at the place, where a problem appears and research is needed. With the infinitely rich material of the Universe and the infinite variety of its forms, where can these persistent and systematic, repeating, and increasing, with the growth of knowledge, analogies come from? To regard them as "incidental coincidences" is to introduce a great

arbitrariness into the world-view and even to come into obvious contradiction with the theory of probabilities. There can be only one scientifically justified conclusion: the *actual* unity of organizational methods is found everywhere — in mental and physical complexes, in living and dead nature, in the work of spontaneous forces and the conscious activity of people. Until the present time, it has not been precisely established, studied, or investigated; there was no *universal organizational science*. Now its time has come.

### §3 Towards an Organizational Science

#### *1. The Organizational Point of View in Primitive and Religious Thinking*

Notwithstanding the fact that there is no universal organizational science yet, its basic point of view was born at the very dawn of humanity, with the inception of speech and thought.

The first words-concepts referred to human labour actions, they were natural because they were the sounds that accompanied the exclamations caused by effort or labour. When they were reproduced in the absence of such effort, they expressed an intention, appeal, or image of it. They were stirred up, therefore, by everything that reminded one of it. For example, the original root "rhag" or "vrag" in Indo-European languages has the meaning "to break up"; the Greek  $\varsigma\eta\gamma\lambda\upsilon\mu\sigma$  ("break"), the Latin "frango" (the same meaning), the German "brechen", or the French "rage", and the Russian words "враг" ("enemy"), "развить" ("develop"), "раз" ("once") and the verbal prefix "раз"— all descend from it. Originally this root was, probably, only a roar escaping from the lips at the moment of striking a blow; but it could be brought to the scene not only during this action or as an appeal to it, but also in

numerous other situations which resembled it: with seeing or thinking about an enemy, or of a weapon which delivers a blow, or of its consequences, that is, of something broken, fractured, etc.. All of these things were spontaneously designated, or marked, by the same sound: it was the original *indeterminacy of meaning* of the word-roots which helped each of them become a starting point for the subsequent development of thousands of other words with more ramified and definite meanings.

This very indeterminacy created the basic condition for human thought about nature, that is, *the basic metaphor*. Metaphor or, literally, the "transfer of meaning", is generally defined as the application of a word which refers to a particular phenomenon, to another, and different, phenomenon, which has something in common with the former, for example, when a poet calls a daybreak "bloody", a spring "tender" or an ocean "menacing". The distant ancestors of the Aryans did not know what metaphor was, but they quite naturally used the same root "rhag" when they saw or imagined any shattering action in spontaneous nature: a falling rock, which crushes everything in its path, a storm, which breaks trees, etc. Natural actions were described using the same words as those for human ones. This is what basic metaphor is. Without it people would not be able to speak about external nature, and therefore would be unable to formulate conceptions of it: thinking about the world would be impossible.

With the aid of the basic metaphor, humanity stepped over the deepest gulf of its experience: the gulf between itself and its everlasting enemy — the primordial forces. The basic metaphor is the embryo and prototype of the unity of the organizational point of view of the Universe. The word was the instrument for the organization of socio-human activities; but at the same time it had come to be used for the unification of experience which related to

the actions of external nature: both were generalized in an organizational sense.

Primitive thinking was not a system, nor was it a "world-view": words-concepts, being closely intertwined with immediate actions, were not thought in their interrelatedness or deliberately grouped into a whole. This specific organization of it only appeared at a later stage of development, that is, when in life itself, thought had begun to be separated from physical and labour effort, when people had been divided into leaders and actors, or executors; organizers and organized. When one person thinks, decides and commands, and another executes, then, we might say, there are two poles: a pole of thought and word and a pole of physical labour. A leader, e.g. a patriarch or military head of a tribe, had to work out plans of very complex and intricate arrangements, which were to be executed by his subordinates; and such plans interrelated images and concepts, rather than actions, which were executed separately, although in a relation of dependency upon them. Thus, the independent organization of thought, thinking as a system, or what is often called a world-view, although it would be more precise to call it a world-understanding, had originated.

In this process, the original unity of the organizational point of view was preserved and even more deeply reinforced. The organization of thinking was certainly dependent upon the organization of labour, for which it was an instrument. And in the sphere of labour it was typical to combine inseparably organizational and executive actions. This was the model of thinking for all kinds of actions — social and labour as well as individual human and even entirely spontaneous. When a human action was not determined by the command of another person, that is, an organizer, it was assumed that the actor had commanded himself and had been his own organizer. Thus he has discovered two sides of himself — organizational, or

commanding, and executive, or passive, the first side being called "soul", and the second — "body". The same was true in regard to any complex in external nature. Animal, plant, stone, stream, celestial body, everything which was perceived as active (and there was no other for primitive thought) — all of these had been mentally organized in accordance with the scheme "soul — body". Therefore it was a direct and naive recognition of the universality of organizational method. And the method of thinking itself, as we will see, was received as already existing from where it had been born, that is, from social practice and the sphere of production.

From this perspective, many of the delusions and "superstitions" of our distant ancestors and of contemporary primitive peoples become quite natural and understandable. Such is, for example, the belief in invocations, the force of magic words and their ability to act upon the objects of nature and change the way spontaneous phenomena go. Human actions are determined by words, i.e. the orders and commands of an organizer; and if it is accepted that the organization of spontaneous actions is similar, then it is obvious that they too should be determined by words, although words pronounced by a competent organizer and in a proper manner, one which is comprehensible to the spontaneous force or object over which we want to exert our influence. It is not without reason that in Russian the word "world" ("мир") means the same as "community" ("община"): to the naive consciousness, the links and relations in a community and those across the whole world are the same. This is an inevitable stage in the development of an organizational consciousness.

The original unity of the organizational point of view remained unchanged throughout all periods of the authoritarian way of living. The world-view of these periods adopted the form of "religions", whose representations of the world were based either on patriarchal

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and tribal or feudal models: in early religions there were separate ancestral deities later substituted by other, more all embracing tribal gods; in more developed societies a long chain of gods, some of which were subordinate, others — their seniors, with at the head, a Sovereign God. Notably, subordinate gods often were obliged to pay tribute or sacrifice to higher deities. The practical meaning of the relation of people to gods is precisely that gods govern both men and things, and that they can, in the areas of their competence, compel things to do what is profitable or desirable for men. Thinking was imbued with a basic, naive unity of method. Both natural and social laws were considered as being perfectly homogenous organizational prescriptions of heavenly power; and their total knowledge was only possible by "revelation", that is, by communication or publication of these prescriptions. There was not even the idea that spontaneous and social processes can have their own laws, unequal for the various fields of experience, and that a fact's conformity with a law and people's obedience to a power are different things.

Thus, growing and crystallizing, experience was continuously and, as if automatically, accumulated in accordance with the same scheme: the Sun goes its daily way from East to West because it is prescribed that way; a disease develops in a certain succession because it obeys the corresponding wish, etc.. The most general and stable regularities of experience are irrevocable prescriptions of a higher deity. All human confidence in their calculations and systematic efforts was based on this irrevocability. Of course the deity, like every other governor, can sometimes rescind or abolish a law that he has established; but this exception, the "miracle" or special intervention is, certainly, a very rare phenomenon. This concept of special intervention embraced apparent violations of habitual regularities, such as earthquakes, unprecedented epidemics, destructive floods, etc. Therefore the idea of regularity itself was



not undermined by them; the concept of the "miracle" was a safeguard for its development, which protected it against everything that could not be grasped by a still incomplete knowledge.

The form of systematization of experience at that time was drawn from an *authoritarian* or *religious tradition*. The "precepts of ancestors" were transmitted from generation to generation; and as the worship of ancestors from very early times fashioned world-views in religious colours, their precepts were perceived and accepted as sacred or divine. With them, organizational experience was condensed into customs or *rules* pertaining both to practice and thought. Everything was determined and regulated by these rules: the organization of the community and of the work of its members, technical methods for the organization of things, world-understanding and the organization of ideas. The authority, which embodied past experience, prescribed the ways in which people had to live, work, think, and even feel; it systematized schemes and methods spontaneously elaborated by previous generations and gave them the form of irrevocable commands.

Originally, the authoritarian tradition was wholly oral. Later it was fixed by religious art; and, with the appearance of written language, its basic substance was put down in the "sacred books", encyclopaedia of religious thinking. They still evidently represent the peculiarities of this type of sytematization which distinguish it so sharply from later types.

There are two major peculiarities here: extreme *conservatism of forms* and *lack of logical order* based on the differentiation of special spheres of experience. The first feature arises from the nature of the sacred tradition: everything in it is irrevocable, everything is the revelation of a higher authority and cannot be modified by human effort. In fact, even this tradition was gradually

modified with the accumulation of new organizational experience, but the process was so slow, that it could not be perceived by the people of the period.

The second feature, lack of logical order in the distribution of material, was called forth by the method of accumulation of experience itself. It was spontaneous, and lacked any system or order; new data were added to this or that sphere of life or thinking and, in a more or less accidental chronological order, implanted into tradition or joined earlier revelations, which grouped around this or that religious authority. Therefore the "sacred books" of various nations contain rather odd conglomerations of quite heterogeneous elements: e.g. arbitrary rules of cult and hygiene, legal and technical ideas, economic customs and political doctrines, etc. Laws of building construction were confused with recommendations for grain and cattle production, prescriptions for dressing and even night-work (as in the famous book of *Leviticus*); theories of the organization of the world or cosmology — with ethical norms, ethnography, geography (as in the book of *Genesis*); hymns for their gods — with the technology for the production of intoxicating drinks (as in the Indian *Vedas*), etc. There is an order in all of this, although it is not a logical one, but, rather, spontaneously picturesque, similar to that of the common way of thought association in our consciousness.

## 2. *The Organization of Experience in the Generalizing Sciences*

Primitive and confused systematization was possible and life-sufficient only due to the *poverty* of the organizational experience of that time. In spite of the absence of more convenient and perfect forms of linkage, in its less economic grouping it still could be learned, as far as it was necessary, by people, and particularly by those, who, as the leaders of social life, i.e. the priests, devoted

themselves to that task. However, with the accumulation of more extensive experience, previous methods of systematization would inevitably prove to be unsatisfactory.

On one hand, the conservatism of the authoritarian tradition impeded the introduction of a number of new and vital acquisitions, and the more rapid, tangible and perceptible for people the march of progress became, the less everything new could be accepted by the old forms and be made to fit the irrevocable religious framework. On the other, the amount of material itself demanded that its grouping become more orderly and economic; otherwise its adoption would be, initially, too difficult and then utterly impossible. Therefore, the system of experience came to be rapidly dominated by the principle of *specialization*.

This specialization was founded upon the practical division of labour; and its essence rested upon the fact that human activities had been divided into branches, each one of which dealt with specific natural objects, developed specific methods, and accumulated specific experience. That is, the farmer, by concentrating his work on land cultivation, stored, mastered, accumulated and transmitted to his successors a quantity of technical and organizational methods and relevant knowledge and accomplishments; but in other spheres of experience he was satisfied with some minimum, required for the success of his farm and the maintenance of communication with other members of society. Similarly the behaviour of any artisan, merchant, soldier, etc. was specialized in his particular sphere of labour and knowledge. With this division of functions, the field of activity for everyone was diminished; but the success of their efforts was increased. Labour in all its branches became more effective, and experience spread more rapidly.

The division of labour formed a basis for the reformation of social life in general, and of thinking in particular. Specialization has narrowed the field of work for the individual, but in return it has increased efficiency and alleviated and accelerated the accumulation of experience. Blacksmith, tailor, farmer, everyone in his sphere learned methods and conditions of production, transmitted by his ancestors, with increased comprehension; and he himself, little by little, at first unwittingly, and then deliberately, mastered these methods and contributed to them. More easily and more frequently, this progress was achieved by borrowing the novelties of the residents of different regions and countries during intercourse in the process of the exchange of commodities, which was itself engendered by the division of labour. In both cases the old organizational point of view could not be maintained any more. Improved methods, new technical and organizational rules were no more considered as divine prescriptions or revelations: when they were elaborated independently, it was evident; and when they were borrowed from outside, it was inadmissible to obey them as the commands of *alien* gods, unless they were adopted only as useful knowledge and no more.

Thus, along with the old religious, sacred, precepted and conservative knowledge, a new one appeared — non-religious, "secular", and *progressive*. It was gathered and accumulated quite naturally by the branches of labour, such as the knowledge of farming, the blacksmith's knowledge, etc. Initially that knowledge was transmitted orally and practically from parents to children and from masters to apprentices. However, with the increase in its amount, this process became insufficient. Then it was written down and at the same time arranged in a system of an utterly new type: it was organized to minimize the effort needed for its learning and keeping in memory, in accordance with the principle of the "economy of forces". And this is a *scientific* principle: experience

started to be organized into "science", or more exactly, individual sciences. Agricultural knowledge gave the material for agronomy, the science of agriculture, the blacksmith's knowledge — for metallurgy, the miner's experience formed the basis of the science of mining, etc. As we see, they are technical sciences. Their number increased with the ramification of social labour and the accumulation of experience in all of its branches; now we count them in hundreds.

The scientific form of systematization can be characterized by its *methodicalness* and *logical* coherence in the processing and distribution of its material, that is, by the aspiration for a consistent application of the definite and precisely established methods; for the unification of what is most similar, and the separation of what is most diverse. It makes impossible such combinations of heterogeneous elements as those of the authoritarian tradition, which lacked methodicalness and logical coherence if not entirely, then used them to a much lesser extent.

So, specialization gave birth to a number of technical sciences. But we know that the systematization of experience did not confine itself to them: there are mathematical, natural, logical, and social sciences. What about them?

Their appearance is bound up with a fact or law of the greatest importance: that in the most diverse spheres of labour, and in dealings with the most heterogeneous elements of the Universe, people continuously use the *same procedures and methods*, which are common to all of them (along, of course, with specialized methods and devices).

For example, we cannot find a single branch of labour, where we would not need to resort from time to time to *counting* or the *calculation* of materials, instruments, working forces, etc. In some

branches the methods of calculation are used especially frequently and need special practical precision, such as in the case of construction and trade; in others, such as livestock production and many handicrafts, they are more occasional and less complicated. Nevertheless, they are the same everywhere; there are no peculiar methods of counting which would be valid for one sphere of life and unfit for others. Therefore, counting could not be introduced to some peculiar *technical* science, or establish such a science with a separate or special object in nature. It has become an *abstract* science, that is, a science which is independent of any separate or particular practical task — *arithmetic*, or in its later development, *algebra*, and so on. Its function is organizational as much as the functions of the technical sciences, but it has a much broader extent and embraces the most diverse spheres of human activity.

Let us consider another method — spatial measurement and co-measurement; this is the essence of the abstract science of *geometry*. Its methods were used even in the primordial times of human history by vagrant hunters for the measurement of the distances of their itineraries, to choose the shortest ways, for semi-conscious calculations of the angle of interception with a hunted animal, etc. With the transition to settled agriculture, it became necessary to apply the same methods more systematically and precisely, that is, as methods of *land measurement* (this is the literal meaning of the word "geometry"): the peace and fate of farming communities depended on the proper distribution of land inside them and between them and their neighbours. The improvement of these methods by the ancient civilizations, which settled along the valleys of the great rivers of the Nile, Euphrates and Tigris, Yangtze, Ganges and others, was especially important. In those countries, river floods every now and then washed away the physical borders between portions of land, and it was important to re-establish them on the basis of exact measurements. Further developments in geometrical

procedures came out of civil engineering, that is, the construction of houses, palaces, temples, pyramids, dams, reservoirs for the regulation of water-levels in rivers, etc. Then the same methods were applied to topographic surveys — for military affairs, trade voyages, etc. It was also important for jewellery (the polishing of precious stones), and even more — for the manufacture of optical instruments, in ornamentics, painting (perspective)... Its objects are most heterogeneous. And again it is difficult to indicate a sphere of the "organization of things", where geometry would not be, to this or that extent, an instructor.

*Astronomy* is often associated with the idea of detachment from everything earthly, of pure cognitive, ideal interest. It is difficult to make a more flagrant and naive error: there is no science which could be more directly practical.

Already in nomadic periods pre-scientific astronomical devices had served for *orientation in space and time* which alone made possible every technology and organization of labour; even at that time people sought their way through forest thickets and boundless steppes, as well as determined the time of day, by the Sun and stars: every co-ordination of effort needs, to this or that extent, their spatial and temporal coincidence. This initial meaning has been preserved by astronomical methods throughout all their further development.

The settled agricultural way of life necessitated the improvement of these methods, mainly for their better orientation in time: for the determination of the periods of field work and the precise division of the yearly cycle of natural processes. Precise calculation of time was especially important for the ancient riverside civilizations, which had to predict and regulate the fluctuation of water levels, on which the fertility of the soil, and the whole fate of society

depended. Thus a highly developed priestly astronomy appeared, although still in a religious, mystical form. Long trade voyages, by land as well as by sea, with their vital demands for orientation in space gave further impetus to the development of astronomy, which had already been liberated from its religious shell. The great astronomical revolution at the beginning of the New Time, namely, Copernicus' system, was primarily instigated by oceanic navigation and distant colonial and trade voyages; to make this navigation easier, Alfonso the Wise commanded a collective of several dozens of astronomers to draw up new celestial tables, which formed the basis for Copernicus' elaboration of his theory.

The organizational role of astronomy is even more important for contemporary scientific and technological practice, as it needs substantial precision in regard to the distribution of working hours and spatial labour relations. The main and universal astronomical device, namely, the clock, regulates the whole organization of social life. Without the clock, it would be impossible not only, for example, to make a train schedule, but also to calculate the time of each labour operation in the factories or the speed of machine work, etc. It is necessary to note that the precise checks and co-ordination of the innumerable clocks, which organize people's life and work, can be achieved only with the help of astronomy; this is one of the functions of the observatories' continuous work. Furthermore, only astronomical goniometrical methods make possible the precise study of terrestrial landscapes for the construction of railroads, giant tunnels through mountains, channels, etc.; the same methods are applied in the manufacture of accurate instruments, the construction of high buildings, etc. The whole contemporary universal metric system has been obtained with the help of astronomical measurements; the meter, its basic unit, which is one forty millionth part of the meridional arc, can be measured only by astronomic and geometric methods.



It is not difficult to understand the reason why the observation of celestial bodies formed the basis of organizational experience pertaining to spatial and temporal orientation. For this orientation, it was necessary to discover a system of particularly stable and durable interrelations in space and time. They were found in the astronomical bodies: their colossal masses and distances completely exclude the influence of casual or minor factors on their locations and movements.

Undoubtedly, algebra, as with geometry and astronomy, contains data and conclusions, which do not serve directly organizational functions but which are the essence of these sciences. Each of them has developed as an independent system, and lives and functions as a whole; and every living whole includes parts, which are necessary only for binding together, for the support and reinforcement of the system, being only indirectly related to its function as a whole. For example, the achievement of every human goal implies many labour motions other than those which directly pertain to it: some serve for breath intensification, blood influx to the muscles and the active parts of the brain, the maintenance of the mechanical equilibrium of the body, etc.; others are merely inevitable, although useless, reflexes caused by irradiation, that is, the diffusion of stimulation from active centres to those that are adjacent to them. Another example is that of a machine, which has a generator of power and working instruments embodying its direct technical purpose, but also contains many parts, which serve only to support the mechanism, friction reduction, etc., as well as elements, which are absolutely useless but cannot be or are, as yet, not eliminated. The same can be said about any organism, any organ, etc. The sciences are not exceptions. The essence of astronomy does not change due to the fact that the satellites of Mars are not used for the determination of longitudes, as are the satellites of Jupiter. Since the celestial bodies are made to serve as instruments of orientation, then even the

most disinterested study of them is nothing more than an aspiration to their mastery, i.e. the improvement of the organizational function of a given science; this is the *objective meaning* of the cognitive being's efforts, even when he does not recognize it.

We shall not dwell on mechanics, physics and chemistry, which, as is generally known, organize contemporary technology in all its various branches. As to biology, we shall admit that it systematizes organizational experience for many kinds of human activity pertaining to the preservation or development of some sort of life, or, on the contrary, to its destruction: land cultivation, livestock production, medicine, pedagogics, social hygiene, etc. make extensive use of biological methods. The science of economics systematizes the experience of the organization of labour and distribution in all its extent; therefore, its schemes of co-operation and appropriation embrace numerous spheres of practice.

We shall conclude our list of illustrations with the abstract science of logic. Its organizational function will be more evident if we consider its origin. In Ancient Greece, when the struggle between the individual and the group became sharply aggravated, the school of Sophists came to the scene, and, within that struggle, preached extreme subjectivism. The Sophists claimed that there is no common moral, political or scientific truth, that every individual had his own truth and that contradictory statements could be proved with equal justification. In a consistent application, this view meant that it was impossible for people to convince one another of a particular point or even *come to a compromise*. However, the rational organization of any practical business is achieved precisely by a compromise pertaining to purposes, means, procedure of execution, etc., between its participants; this is the *organizational* process executed through speech, thought, and "discussion". The school of Socrates challenged the Sophists and elaborated formal logic, systematized

later by Aristotle, which gave people norms and means of mutual conviction, of discussion culminating in agreement, i.e. precisely of reaching a compromise. Logic constructs corresponding organizational methods which pertain not only to a single sphere but for any specific branch of life<sup>3</sup>.

Thus, we see that the abstract sciences embrace that part of organizational experience which is not confined by the bounds of a particular technical speciality; they have a number of universal methods which can be used in all, or, at least, in a vast majority of them. If this is true for the extremely abstract sciences, such as mathematics, astronomy and logic, then it is even more evident for other, natural and social, sciences.

However, the domination of the principle of specialization was not shaken by the development of the abstract sciences: they submitted themselves to it and came to be specialities themselves, becoming as independent as any other specialized branch of labour. This has facilitated and accelerated their progress, but obscured their meaning for life. Their proponents, the scientific specialists, with narrowed fields of thinking activity, fail to fully understand their practical essence and universal organizing function, and the organizational role of these sciences in the social realm became imperceptible. This called forth the idea of a "pure truth", of truth itself, independent of any kind of practice, whereas the truths of the abstract sciences are independent only of narrow specialized practices of this or that particular branch of labour, but pertain to *all* labour practice in its social and historical integrity. The idea of "pure truth" prevails in the world-view of scientists even now.

Obviously, they cannot help seeing at least some practical applications of this "pure truth"; but they consider them as something accidental to the truth, irrelevant to its essence and

unnecessary for it. Truth is considered as belonging to a peculiar logical world, which is higher than life, and this is the reason why truth is able, in some cases, to govern life.

The case of astronomy is especially demonstrative of the narrow-mindedness of specialized thinking. Many scientists and wise men have written about its usefulness and practical achievements for technology; they praise its applications to land cultivation, navigation, etc. However, as far as I know, no one has admitted the irrevocable fact that astronomy co-ordinates and regulates *all* our social and labour life, daily communications and spatial and temporal relationships of human action. Nobody has noticed that every time we use clocks we submit ourselves to the astronomical experience which produced them and which continuously controls them, and that the same can be said about any more or less precise orientation in space.

### 3. *Folk Tektology*

No professional can live wholly and exclusively inside his speciality: his knowledge and experience inevitably go beyond it, he has to have relations and communications with other people. For example, as a consumer, he must have a conception of the diverse products of the other branches of labour; as a father and husband — that of the raising of children and the family budget; as a citizen — of state organization, etc. But while within his speciality he strives for the precise, definite, complete and orderly design of his experience, for its scientific organization, in all other areas he is content with some minimal, fragmentary information and indefinite, vague, "lay" or "worldly" experience.

This worldly experience plays an immense role in life by cementing an uncoordinated and formally anarchical collective. And besides, this experience is rather homogeneous and monotonous for everyone who lives in the same social environment. In spite of its non-scientific character, its content is very broad and general. It has to do with the most diverse areas of life: with the organization of things, at least in domestic life; with the organization of people — in family, daily neighbour and other inter-relationships and with the organization of ideas — in so called "public opinion".

This life experience — incomplete, but versatile, non-scientific, but vital and practical — maintains a naive unity within the organizational point of view and a spontaneous, but profound, tendency towards a unity of organizational methods.

It is stored primarily in the national language. It is true that, on the basis of specialization, particular branches, technical and professional languages and scientific terminologies, like the branches of one tree, are kept aloof even in this realm; and class diversification gives rise to an even wider separation between the dialect of the ruling classes and that of the subordinate masses. But nevertheless, a significant common linguistic nucleus, which is necessary to bind the different social groups and classes together and to ensure their mutual understanding in practical communications, still remains. This is what crystallizes and, in a primitive manner, arranges the traditions of the past and the experience of millennia.

A national language with all its broadness preserves the basic metaphor. Its judgements or "propositions" about human or social activeness are organized identically to those about spontaneous activeness; for example, the subject may refer to animate or inanimate, empirical or abstract things, the symbol of a body, a process, or an action; and the same verb or adjective may serve as

predicate for all these diverse subjects, that is, as a direct characteristic of them. In accordance with the division of the family, which still is the basic social unit, all complexes in external nature and the ideal abstractions of the majority of languages are subdivided into men, women and sexually underdeveloped children; there is no other reason for the division of nouns into masculine, feminine and neuter genders. This peculiar monism can be easily observed all along the line of the development of grammar.

The same tendency is equally strong and even more profound in the linguistic "lexicon", i.e. in its verbal material. Every original grammatical root referring to collective labour actions has given birth to the heredity of thousands of words-concepts; and this is the case in all areas of experience, physical as well as mental. One Indo-German root, "mard", whose general meaning is "to crush" or "to splinter", has, through innumerable transitional and intermediate nuances, begotten such words like Russian "молот" ("hammer") and "малый" ("small"), "смерть" ("death") and "море" ("sea"), "молодой" ("young") and "медленный" ("slow"); German "meer" ("sea") and "erde" ("earth"), "mord" ("murder") and "mild" ("mild"), "mal" ("once") and "schwarz" ("black"), etc. As research shows, all of them imply one and the same idea, which is of major importance to all organizational experience — the idea of division into parts, in all of its varieties and applications<sup>4</sup>. The Russian word "крыть" ("to cover") correlates with a number of words: "кора" ("rind"), "корень" ("root"), "короб" ("box"), "корабль" ("ship"), "череп" — "черепаха" ("skull" — "turtle"), etc.; other kindred languages also have many such words, as per the German "korb" (basket), French "corbeille" ("basket"), French "ecorce" ("rind"), "croute" ("crust"), etc. All of them imply an idea of the same organizational devices which are applied both in technology and spontaneous nature: the combination of a less stable and more delicate content and a firmer membrane, which protects them

against destructive external pressures. The Greek root "ταγ", which is also widely spread in other kindred languages, gave birth to the words "τασσω" — ("to build"), "τεχτων" — ("builder"), "ταχτιζ" — ("military formation" and "order" in general), "τεχνη" — ("handicraft", "art"), "τεχνον" — ("child"), and a great number of similar examples. Being sharply heterogeneous as they are, these concepts still imply a common idea of *organizational process*<sup>5</sup>.

A word often preserves its organizational idea, even when the current, disconnected thought of people finally loses it. For example, the organizing role of religion wholly escapes the mediocre, lay thinking of our epoch. However, the word "religion" itself points to this role, whether its origin be from the Latin "religare" ("to connect") or "relegere" ("to gather"). Similarly, the careful study of the usage, if not the composition, of the word "душа" ("soul") in Russian and other kindred languages, can give a solution to one of the most obscure philosophical and scientific mysteries. It is often used to mean "organizer" or "organizing principle", for example, when we say that this person is the "soul" of the affair or society, i.e. the active organizer of the work or life of the organization; "love is the soul of Christianity", that is, its organizing principle, etc. This shows that the "soul" is set off against the body precisely as its organizer or organizing principle, i.e. that here we have a "simple transfer of the concept of a certain form of co-operation to people or other things", a differentiation between organizer and actor, or authoritarian labour relations. And this is the genuine solution of the problem of the origin of the idea of "soul". The collective genius of language here, as in many other cases, has turned out to be wiser than the individual efforts of professional scientists, who are the children of a disconnected and anarchical society.

Further, worldly experience has been preserved by more complex forms of so called folk wisdom: by proverbs, parables, fables, tales, etc. A lot of them are expressions of the most general laws of organization in society and nature. For example, the Russian proverb "Где тонко, там и рвется" (literally "where thin, there torn" which roughly means "the chain is no stronger than its weakest link") is a figurative, non-scientific, but true expression of the most general law, which governs the processes of de-organization at all levels of the Universe; any whole starts to de-organize, when at a single point its resistance becomes insufficient in comparison to external forces: textiles — where they are thinnest; a chain — at its weakest or rustiest link; the organization of people — where the linkage of people is weaker; the living organism — where its tissues are least protected; a scientific or philosophical doctrine — where the conjunction of its concepts is most vulnerable to criticism, etc. The proverb "Куй железо, пока горячо" ("strike while the iron is hot") is not just a technical rule for a blacksmith; it is a principle for all practice, for any organizational or de-organizational business; it expresses the necessity of taking advantage of favourable conditions because of their limited duration and irretrievable loss. This rule is equally important for the farmer (in respect of sowing and reaping); the politician or strategist (in respect of the changing combinations of social or military forces); the artist or researcher (in respect of the favourable combinations of external conditions or psycho-physiological states, so called inspiration, which supports their work); as for a person in love, etc. The parable about twigs, which can easily be broken by a child, and the besom, made of them, which cannot be broken by a strong man, is a popular figurative expression of the universal idea of organization; it is also equally applicable to people, things, and ideas. Certainly, not every embodiment of folk wisdom embraces organizational experience so broadly and deeply; however all of them refer to it, not in a narrow specialized sense,



but biased for dissemination beyond the boundaries of the separate branches of living practice and thought.

However, this monism of folk tektology alone cannot fight the spirit of specialization and, with the march of technical and theoretical progress, yields to it domination over the public consciousness to an ever larger extent. The case is that folk wisdom is not only non-scientific in its form, but that it is essentially deeply stagnant, it belongs to the past and strives to preserve it; in comparison with it, specialization represents a progressive line of life. However, while defeating naive and conservative monism, it gives birth to another, scientific and progressive monism, which is, vitally as far above specialization as it is above folk tektology.

#### 4. *The Divergence and Transfer of Methods*

Specialization is a necessary stage in the development of the forms of organizational experience. Owing to it, each branch of labour and knowledge has collected vast amounts of material, and methods have been improved much faster than before. However, it has another facet, which becomes stronger and sharper with its development.

Specialization leads to the *divergence of methods*. In its independent development, each practical or scientific branch goes its particular way and moves away from others. Consequently communications between them diminish, increasing their remoteness. The methods of one are unyielding to the influences of the methods of others, and they have no contact or cross influence. Each of them creates its own specific language, so that similar correlations are expressed differently by them, thus masking the similarity itself; and at the same time the same words receive absolutely different meanings, making co-operation even more difficult. This is especially relevant

to the things, which are most often encountered in experience and therefore expressed in speech. For example, in Russian we say "умереть" ("to die") — about people, "издохнуть" ("to cease") — about animals, and more often "околеть" ("to stiffen") — about domestic animals; fishermen say "уснуть," ("to fall asleep") about fish, but about river crabs — "перешептаться" ("to stop whispering"), that is, to cease their peculiar rustling. The same can be said about science.

For example, the concept of "adaptation" is one of the bases of contemporary biology, it lies at the foundation of all evolutionary theory. But in political economy the term "adaptation" is hardly ever met or is met very rarely, generally as a metaphor. However, all economic processes are in their essence precisely the processes of adaptation of people and collectives to their natural and social environment. On the contrary, the term "competition" is used by both sciences, but with different meanings. The competition of plants for the nutrient juices of the soil, which compels them to stretch their roots even farther, significantly differs from the competition of merchants for consumers, which forces them to reduce prices. This identity of the term has led to conceptual confusion and the many errors of so called "Social Darwinism".

The most typical and important example of the multiplicity of designations called forth by specialization hiding the principal unity of correlations, is the concept of *organizational process*. Almost every branch of science and practice has its own peculiar expression for it, and all of them are taken by lay thinking as the same number of different concepts. For example, in engineering, i.e. in the sphere of the organization of things, the most common term is "to produce" a product; it means to organize certain elements of the environment into a premeditated combination. But in regard to a building or a ship it is "to construct", in regard to a railroad — "to build", in

regard to fortifications — "to raise", etc. The basic meaning is the same; and the nuances of these concepts wholly depend on the nature of the objects of the engineering activity and therefore are introduced needlessly, for they are sufficiently implied by the names of these objects. The same class of organizational synonyms also contains the words "to make", "to manufacture", and others.

In the field of cognition, when we deal with the mental organization of elements into premeditated wholes, it is called "to invent", for example, a mechanism or machine; note, that this combination of words is imprecise: the machine is "constructed", while what is invented is a mental system of relationships, which serve as an organizational point in the process of the construction of the machine. Another term, "to discover" (also "to establish"), for example, a new regularity, also means the expedient mental organization of a certain amount of elements, and the synonymic nuances here also depend on the nature of object. In art, this divergence of usage can also be found, e.g. "to create" a piece of art, "to compose"<sup>6</sup> a novel or poem (the structure of the word "to compose" is a literal translation of the term "to co-ordinate").

The concept "to organize" is very often expressed in words, which refer to the basic or most typical technical operation of a given branch: "to sew" dresses or boots, "to forge" weapons, "to paint" a canvas, "to write" a book. All these concepts imply, along with the operation to which they refer, the whole organizational process of which they are parts. And sometimes, a designation is taken from the field of concepts with opposite meanings, which refer to de-organization: "to pitch" a camp, "to lay out" a garden, in the sense, precisely, of organizing with a proper spatial distribution. The most general term of human practice, "to do", means at the same time both "to organize" and "to de-organize".

Spontaneous organizational processes also get different names in different sciences. In biology, they are most often referred to by the terms "adaptation" and "development": the former is used when a process takes place between a living form and its environment (for example, "the adaptation of a species to its natural environment"), the latter — when it takes place inside the living form itself (for example, "the development of the organism"). In psychology, the most common term is "association", in social sciences — "organization", in mechanics, physics, chemistry — "formation" (for example, of mechanical systems, optical representations, chemical combinations).

All of these are a very small portion of the existing special designations of one and the same principal conception. As we saw, each of them has its peculiar nuance, but this nuance is fully implied by the *object*, which is referred to by the idea of organization, and therefore is absolutely useless, as the object has been already indicated. However, the force of habit, which has been worked out over the centuries, is such that we would not be able to stand the sound of the expressions: "to organize" a building, ship, dress, canvas or book, although they would be not only sufficient, but also much more precise, than the usual formulae: "to sew" a dress, "to write a book", which reduce complex systems of organizational actions to a single and far from vitally important term.

The elaboration of special languages has not only consolidated the divergence of methods of different branches, but also created the appearance of divergence where there was none. Even where common methods have been preserved or developed independently, special languages have concealed the fact from people's consciousness, compelling them to study the same thing under different names. This excluded communication and co-operation between branches in the process of the development of their

methods: each one was left to its own, limited resources. This was the cause of the *poverty of combinations*, which impeded and decelerated development. Frequently it happened that one branch of technology or cognition fruitlessly struggled within the framework of its obsolete, clumsy and exhausted methods, while another, adjacent branch had already developed means for the resolution of its back-breaking tasks, which nevertheless remained unknown and incomprehensible to those outside it.

Possessing individually, only insignificant portions of the methods and views, accumulated by society, and, having no opportunity to choose among them or combine them in the best way, professionals are unable to deal with a continuously growing body of material and to organize it in a harmonious and integral way. It results in an ever growing conglomeration of raw material, which often suppresses progress by its quantity. Learning the totality becomes more and more difficult, and leads to the further fragmentation of branches into smaller and smaller areas and a subsequent narrowing of outlook, etc. This was noticed long ago by progressive scientists and thinkers, who fought against "corporate narrow-mindedness", primarily in science.

However, this fragmentation was not absolute; from the very beginning there was another tendency, which for a long time was not noticed due to its comparative weakness; but nevertheless it forced its way forward and was strengthened, especially in the last century. Communication between the branches still occurred, and the methods of some of them penetrated into others, sometimes provoking genuine revolutions. A number of great discoveries in science and technology, almost the majority, can be reduced precisely to *the transfer of methods* beyond those areas where they had originally been elaborated.

Thus, the use of steam engines has been transferred from one branch of production to others, leading everywhere to a significant improvement of the efficiency of labour; for example, they were utilized for transport several decades after they had transformed a significant part of industry. The introduction of turbine-plants, for a long time known by water engineering (the simplest turbine is a toy called "Segner's wheel") was the next important step in the development of steam engines.

A further, and even more important, advancement was brought about by the introduction of the "explosive" principle, which for several hundreds of years ruled over the technology of war and destruction. Engines constructed on this basis are notable in that they are very powerful despite their small size and mass; and they have conquered the ocean of air for mankind.

The extraction of precious metals, jewellery and the manufacture of drugs have developed methods of precise weighing. Consistently applying them to chemistry, A. Lavoisier produced a great scientific revolution. The practical principles of machine production, scientifically formulated by physicists, have become the laws of thermodynamics and then of general energetics; all the modern unification of physical and chemical sciences is based on it. Astronomy was transformed by the principles of mechanics; physiology came to be an exact science through the methods of physics and chemistry. Psychology profoundly changed its character due to the introduction of the methods of physiology and general biology, which also contribute to its scientific precision.

The transfer of methods is an exhaustively objective and irrevocable proof of the potential of methods to develop towards unity, i.e. towards a monism of organizational experience. However, this conclusion cannot be grasped by the specialist or by the common

reason of our time in general. Every step, approximating this unity, meets with violent resistance from the majority of specialists; the history of science provides us with a great number of such examples. And, when the unifying idea finally wins and is adopted by the majority of specialists, they elaborate it with energy and success, but not in the least does this prevent them from being resistant to the next step. This resistance originates in the very thought mechanism produced by specialization; and this mechanism is such that the specialist unwittingly strives to demarcate his familiar and habitual field of work from the rest of experience, where he feels alien and diffident. When the borders are broken, when there is a rapprochement of fields and methods of work, the specialist perceives it as an invasion by something strange, even hostile, of his private economy; and it is much more difficult for him to study these new things than to go along old and familiar paths. This is the reason, for example, why the broad and most deeply unifying idea of the XIX century, that is, the law of the conservation of energy, had to struggle so long for recognition.

The paper by Robert Mayer, which for the first time had clearly expressed and justified this law, was rejected by a special physics journal. Darwinism had to endure no less a violent fight with the hostility of the scientific community. And before C. Darwin, the fate of the ideas of J. B. Lamarck is well-known, as well as the official victory of the opponent of the evolutionary view J. Cuvier over its proponent Geoffrey Saint-Hilare. When the physicist D. Hughes accidentally discovered electric waves with the help of his microphone, which received on the street, through air and walls, the oscillations of electrical discharges, produced at his laboratory, his friends succeeded in convincing him not to publish this fact or his conclusions: they said that he "would scientifically compromise himself". And this phenomenon, which unified the realms of light

and electricity, had to be re-discovered twenty five years later by H. Hertz.

Even such practical and essentially simple ideas as the application of steam power to water and steam vehicles, when it was already used in industry, gave rise to the distrust and mockery of authoritative people, mockery such as: "This is as probable as travel on Congreve's rocket". For men educated in the spirit of specialization it was self-evident that methods suitable for a factory are of no use to ships or vehicles. Facts like this can be cited without end.

### *5. Contemporary Thinking and the Idea of the Universal*

#### *Unity of Organizational Methods*

The unity of organizational methods, struggling through the narrow framework of specialization, is, so to say, dictated by the modern development of technology and science. The means, used by contemporary lay and scientific thinking to get rid of this unpleasant and alien view, are characteristic. First of all, the very word "organization" is applied only to living beings and their groupings. Even the technical processes of production aren't recognized as organizational. This thinking cannot grasp, as if it does not see, the simplest fact that any product is a system, organized from material elements by adding the elements of human labour energy, and that consequently every technology is the organization of things by human efforts and in response to human interests.

Concerning the products of the spontaneous forces of nature, here living "organization" is opposed to dead "mechanism", as if to something essentially different, separated by an unbridgeable gulf. Meanwhile, if we look attentively, at how the word "mechanism" is used in science, the gulf will immediately disappear. Every time the



scientists succeed in *explaining* some function of a living organism, they start to call it "mechanical". For example, the functions of breath and heart were for a long time considered the most mysterious phenomena of life; and when they were understood, they came to be regarded by physiologists as ordinary "mechanisms". The same thing occurred with the transmission of nervous stimuli from the organs of perception to the brain and from the brain to the muscles, when the electrical character of the neural current was discovered. Meanwhile, did all these functions cease to be a part of the organizational process of life, its necessary and essential elements? Certainly not. The "mechanical aspect of life" is simply everything that has been explained in it. A "mechanism" is an *organization which is understood*, and no more. A machine is "just a mechanism", because it has been organized by people and therefore is principally known to them. Our contemporaries refuse to regard their own body as "just a mechanism" for the same reason as savages and infants regard clocks not as dead machines but as living beings. The "mechanical point of view" is, precisely, the unified organizational point of view in its development and victories over scientific isolation.

However resistant to this point of view the thinking of the contemporary specialist is, even he should be struck by the increasing number of applications of homogenous methods and schemes to the most diverse branches of scientific experience. So there is a growing need for some understanding of this undoubted and irremovable unity, which represents a mystery to the specialized consciousness, reared on isolation and looking for borders, limits and partitions. And it wants to understand it precisely in a way, which would mitigate it as much as possible, reduce its significance, find out that it is either imaginary, or seeming, or subjective, or artificial; that it is by no means rooted in the very nature of things, in real being. The thought of those philosophers imbued with the

spirit of specialization, i.e. of their majority, moved in this desirable direction. They have succeeded in elaborating two theories, which fit their task and sentiments.

The *first one*, Kant's, adopts that all unity of schemata and methods depend exclusively on the knowing subject and are completely "subjective". A man can think only in certain forms, which from the start belong to the very nature of his cognition. These forms he imposes on facts and then refers to reality itself, to the nature of the studied world; and that is certainly erroneous; Man, using Kant's words, "imposes laws on nature", but only in the sense that they are the laws of his cognition, which he cannot escape, nor go beyond their framework; all his experience is packed into them, because he himself is confined by them and has nothing besides. Everything he sees occurs in space, time, causal interrelations, etc., but this is only "appearance", just a "phenomenon"; these "forms" are contained in himself, in the subject, and not in the things "in themselves", in the object. This is the basic idea of the old "epistemology", or theory of knowledge.

Here is an example of how this view is applied to atomistic theory in physical and chemical sciences and to the kindred concepts in other fields: The "atomistic hypothesis is psychologically demanding. We cannot grasp continuity other than by dividing it into parts; and here is where we get the concepts of time, space, the straight line as the element of a curve, the atom, the cell as the biological atom, the human individual as the social atom, etc. The *atomistic hypothesis depicts the constitution of our cognitive capacities, rather than the constitution of bodies*<sup>7</sup>.

Touching upon the hypothesis of W. Crookes regarding a primary substance, or "protile", which, by "aggregating", i.e. becoming denser, by grouping into tighter combinations, presumably

generated the chemical elements (modern theory has shown that this "protile" is a combination of positive and negative atoms of electricity), M. Goldstein writes: "It is not the protile, even if it had ever existed, which had the propensity to aggregate, but W. Crookes himself who had the intention to aggregate protiles in order to represent some *picture...* of the origin of matter from the primary substance"<sup>8</sup>.

Stretches of like arguments are very easy to discover. It is wrong to conjecture atomism even in the concepts of space and time. The atom is meant precisely as something that cannot be divided into parts, i.e. in the sense of the absolute impossibility, or impossibility without alteration of the very nature of the divided object. However, modern thought depicts and endows space and time precisely with their unrestricted divisibility, i.e. with "non-atomism". But this is not what is most important.

Let the living cell be a biological atom, and therefore it is "psychologically necessary" that we recognize its separateness. But was it not also demanded that we *see* it beforehand in the microscope? And had it been seen due to this "psychological necessity"? But while the cell was still undiscovered and its alterations and transformations untraced, there was not even an idea of the cellular constitution of living bodies. Certainly, they were represented as constituted of these or those elements, but the unified scheme of cellular organization did not and could not exist at that time.

Let us choose another illustration. The study of electrical and magnetic forces frequently makes use of the scheme "attraction — repulsion". The same idea is contained in a great many notions from other fields of science and life: from molecular theories to descriptions of the interrelations of animals of different sexes, which

are attracted, and of the same sex, which are repelled, or in the descriptions of personal characters or mental images, etc. Certainly, it also depicts the "constitution of our cognitive capacities, rather than the constitution of things"; it is also "subjective", i.e. it depends on the knowing subject. But if it does not depend on the "constitution of things", then it should be universally applicable: everywhere we find the "phenomenon" of attraction, there should be found the "phenomenon" of repulsion as well. Regrettably, this is precisely not the case for planetary attraction, which so unpleasantly rivets us to the Earth. "The constitution of our cognitive capacities", which "strives" to complement attraction with repulsion, is impotent to give us the most important thing, i.e. the fact which is needed. Obviously, the "constitution of things" must be involved here and laws can be "imposed" on nature only in agreement with it — in the struggle with its spontaneity and its mysteries.

Truly, there are certain forms of thinking, which people use to consolidate their experience; but they are by no means the eternal "constitution of cognitive capacities". They are means of the organization of experience, which are developed and altered with the growth of experience and the alteration of its contents. "The constitution of the cognitive capacities" of the animalistic savage demands that every moving thing — human being, animal, Sun, stream, clocks, and probably everything in general — should have its "soul"; but for us this form of thinking is obsolete. For us, space and time are infinite; but this was not the case in Ancient times. "Atomism" appeared in Antique thought with the development of *individualism* in society, that is, with the alienation of individuals. People had to think about themselves, and other people, in terms of isolated units; and they transferred this habit to the idea of nature: "atom" in Greek means the same as "individuum" in Latin, i.e. "indivisible".

I used to meet the son of a philosopher-epistemologist, who called a table and a stool "table-daddy" and "table-child". The epistemologist should have learned by this example, what the "forms" or "categories" of thought are. The meagre experience of the family circle had provided the child with the habitual correlations of similar things of different sizes; these correlations have been introduced into his "constitution of cognitive capacities", and he tried to use them for the organization of his further experience. Similarly, a savage, living in a community organized through authoritarian leadership and passive submission, thinks, i.e. organizes the world in his consciousness, in a similar manner, of the existence of an authoritative "god", and of people and things, which are subordinate to him; and people and other things the savage organizes by means of an authoritative, dominating "soul" and a passive "body".

Similarly, the individualistic isolation of life has provided philosophers with a scheme of the atomic isolation of the elements of the world, etc.

The point of the matter is obvious. All these unifying schemes are means of the organization of experience, its instruments or "forms". But it is clear that an instrument of organization should depend both on who is organizing and therefore who creates and makes use of this instrument, and what is organized, i.e. the material of experience. For example, the design of a working tool should fit both the hand and the strength of the worker and the properties of the thing to be processed by this instrument: delicate instruments, suitable for an educated European worker, are useless for a savage, and instruments for wood processing are of no use for grinding metal. In this respect, there is no principal difference between material and ideal tools, as there are no differences in regard to their historical changeability.

*Another* view on uniting schemes may be called the "philological" or "symbolic" approach. It is very similar to the previous outlook and it reduces the origin of these schemes to *language*, to words, and to the elaboration of similar designations or symbols for different fields of experience. Here is an example of such an interpretation: "One and the same Laplacian equation can be found in the Newtonian theory of gravitation, hydrodynamics, the theory of electrical potential, the theory of magnetism, the theory of heat diffusion and many others. What does this imply? These theories seem to copy each other accurately, they elucidate and explain each other, they borrow each other's language. Ask an electrician, what services have been provided by the term "the current of forces" suggested by hydrodynamics and the theory of heat..." etc.<sup>9</sup>

The main problem here is perhaps a reticence about why one branch of experience can borrow its language from another and why these "terms" are so powerful. It is suggested that this power belongs to symbols as they are, and that the existence of some "common language" is a sufficient explanation of it. But in fact this is not the case. The use of common terms is sometimes harmful to understanding and clarity, as we have seen in the case of the concept of "competition" in the general theory of life and political economy. Equally misleading and scientifically vain was the use of language which described an individual organism for the description of social constitution and life by the school of "organicists": they looked for various organs and tissues in society, which would be similar to those of the living body, and made artificial rapprochements and obscuring distortions instead of seeking out truly universal organizational schemes.

In fact, common language is *compelled* by the unity of organizational methods and forms, and *expresses* it. Everywhere it is merely produced later than this unity is discovered.

In many cases, when the unity is already striking, common terms still do not exist — they are still different due to their specialized language.

For example, the usual constitution of plant seed and animal ova can produce an illuminating illustration of the coincidence of independently developed organizational forms. In both cases, there is an embryo, surrounded by nutrient juices and then by a more coarse membrane of "skeletal" type. Frequently, even the chemical compounds of the nutrient layers are similar: one has a prevalence of nitrous combinations, i.e. proteins and similar matter; the other contains non-nitrous substances, i.e. adipous and saccharine matter — in the ovum, and oil and starch — in the seed, although the location of the layers may be different. The unity of the schemes of constitution had been noted here long ago; but common terms were introduced, mainly due to the progress of organic and physiological chemistry only gradually.

Another illustration. The central part of a female flower is occupied by a channel, which serves as a path for its impregnation. At the front, it is surrounded first by more delicate folds of tissues, and then — by more coarse ones ("corolla petals" and "calyx"). And in its depth, there is a more or less pear-shaped organ, where the development of the embryo takes place (the "pistil"). Precisely the same description of architecture, omitting the botanical terms, can be applied to the female organs of, for example, the ape or human being. But it is clear, that the "unity of language" here poses the problem of the unity of the scheme of constitution, rather than resolving or settling it.

In spite of innumerable parallels and coincidences in the most diverse spheres of experience, the old, anarchically fractional world could not, from its social basis, come to the idea of a universal unity

of organizational methods, to the task of the universal organizational science.



6. *The Historical Necessity and Objective Preconditions of Tektology*

In the first edition of this book, two years before the World War and five years before the Revolution, I wrote: "The vital imperfection or contradiction of specialization, consists in that it can gain organizational experience only by its increasing fragmentation, which undermines its integral relationships,— this contradiction has not been perceived by mankind for centuries, because it did not lead to significant practical discomfort. The organizational tasks being put forward by life were successfully resolved by specialization, because they were tasks of a *partial* character.

Society, which is based on the division of labour and the exchange of commodities, and which does not represent an integral organized system of labour, cannot express its task on any scale other than partial. This is self-evident in regard to each of the millions of separate farms and enterprises, which comprise such a society. Certainly, there is the State organization whose tasks are formally concerned with society as a whole. But even they are raised in specialized form, as military, financial, legal tasks, etc. With all their broadness, they are fully partial in their character. It is clear that sciences which generalize organizational experience cannot, in this situation, grasp their tasks on a universal scale.

But with the growth and development of society its lack of integral organization affects it increasingly painfully, and to an ever larger extent. The great mass of living activities continuously accumulated by it can preserve its equilibrium only with increasing effort and lesser perfection. Acute and chronic diseases of the social system — disasters of violent competition, local and global crises, increasing international tension in consequence of the fight for markets,

unemployment, ruthless class conflicts — all this together leads to an immense waste of social forces and creates an atmosphere of general uncertainty about the future. These are the threatening manifestations of *universal* de-organizational processes, and to fight them with methods of a partial character, those which are possessed by specialization, is, essentially, to doom oneself to failure.

So the march of life itself ever more insistently and urgently puts forward organizational tasks in their new, integral, rather than specialized and partial, form. And now as humanity is going through the transitional and intervening age: it still cannot attempt the immediate fulfilment of universal tasks, but partial and accessible problems are put forward and resolved by it in an ever more broad and, in comparison with the past, truly grandiose manner.

In practice, this process is reflected in the immense growth of industrial enterprises, on one hand, and class organizations, on the other. Of the mass of individual enterprises the most stable in a situation of general social instability are the largest ones; they absorb other enterprises and become even larger. The joint-stock system, and then syndicates and trusts develop this tendency much further. There are enterprises with hundreds of thousands of workers and employees, such as the Krupp joint-stock factories or American Steel, oil and other trusts. These are enterprises, which embrace a whole industrial branch of a huge country or, even, several such branches, which before that were separate. And the organizations of different social classes — political, cultural and others — are developing even faster, partially transcending national and state borders and becoming international, even global, organizations.

However, as the integral organization of the social system is absent, its oppressive essential disbalance with all its consequences stays: and

they are aggravated by the accelerated growth and increasing complexity of the social process. The idea of the necessity of the transition to integral organization step by step captures the thought of intellectuals, especially the economists, sociologists and politicians, who belong to different, rather than the same, classes. With all of this, the extreme discord of their interests, aspirations and understanding of the ways of social progress is still at full strength: some assume that universal social organization can be realized by financial and industrial capital, which has already created cartels and trusts; others entrust that mission to the government and intellectuals — functionaries, scientists and engineers; a third group find this force in the increasing strength of the working class. There is no need to investigate now, whose views are correct. It would suffice to note what they have in common, and, on this basis, to determine the size and character of the organizational task, which is put before humanity: this is not dependent upon which social force will carry its burden.

It is easy to note, to what extent this new task is incommensurable with those, which have been put and resolved before. *The whole sum of the working forces* of the society — tens and hundreds of millions of variously differentiated units — should be harmoniously combined into one collective and precisely co-ordinated with the entire available *sum of the means of production*, i.e. the sum of things available to society; at the same time, this giant system should be correlated with the *sum of ideas*, prevailing in the social environment; otherwise the whole would be unstable and the mechanical aggregation would transform into an internal struggle. Obviously, this triple-faceted organization — of things, of people, and of ideas — cannot be constructed in any way other than on the basis of scientific premeditation, i.e. of the whole organizational experience, accumulated by humanity. But it is also obvious, that in its present form, fractured and rent into specialized sciences as it is,

it is incapable of this. It is necessary, that this experience itself be organized in an integral and harmonious way; otherwise its application will not be able to go beyond fragmented and partial tasks. Therefore, what is needed is a *universal organizational science*.

It would be a great, truly childish naiveté to think that the unified system of social labour could be arranged in a common, empirical way, as the majority of people now arrange their private economies, or by simple agreement, parliamentary discussion and resolution, etc.. However, this view is quite widely held. Of the three facets of social activity the organization of things by its very object, is, doubtlessly, the least complicated; but nevertheless, would the technology of machine production be conceivable without the exact specialist sciences? And when we deal with the organization of the other two, much more complex, facets of the social process and with the mutual co-ordination and adaptation of all three of them, then the necessity of a science, which would embrace them all together and in parallel, becomes obvious and indisputable.

However, this science cannot arise at one moment, without an historical background: organizational experience develops continuously, its basic forms appear consecutively, step by step. It would be absolutely fruitless to speak about a universal organizational science, if reality itself were not to provide us with its elements, if there were no trace of the lively, real, tendency of its appearance.

Since then the way things have gone has clearly put the organizational tasks of humanity on a world scale and exposed the feebleness of older views and thought methods for everybody. Mankind needs a *principally new* point of view, a new *method of thought*. But they arise only either with the development of a new

method of organization for the whole of society, or with the appearance of a new social class. In XIXth century such a class appeared — it was the industrial proletariat.

Its [i.e. the industrial proletariat] living relations, the conditions of its work and its struggle, contained the premises of a method of thought, which had not existed before, and a point of view which had been absent. Time was needed for it to mature, to be understood and expressed. But now it is quite clear, and its foundations are certain.

The development of monistic, scientific organizational thought has been impeded by the specialization and anarchical fragmentation of the labour system. The major and constant conditions of the social life of the industrial proletariat provide the starting point for the overcoming of the spirit of specialization and anarchy.

With the improvement of machinery, the role of the worker changed its character. The deepest disconnexion within the framework of co-operation was that which separated the organizer from the actor, mental from physical efforts. In scientific technology, the worker's labour combines both of these types. The organizer's work is the *management and control* of the actor; and the actor's work — *physical influence* on the object of labour. In machine production the worker's activities are the *management and control* of the "iron slave" — the machine — by his *physical influence* upon it. The elements of the working force here are those which before were needed for organizational functions — technical knowledge, wits, initiative in emergencies, and those, which before, were characteristic of the functions of the actor — deftness, quickness, skilfulness of movement. This combination of types of labour was only faintly discerned at the beginning of the development of machine technology, when the worker was a living

appendage of the machine, performing crude, simple movements with the mechanical skill of his hands. The combination of types becomes sharper and more definite with the improvement and increasing complexity of machinery, their closer approximation to the type of "automatic", self-acting mechanisms, where the essence of work becomes living control, directed intervention, constant active attention. The combination will be fully realized, when even higher forms of machine are designed — self-regulating mechanisms. This, of course, is the task of the future; but even now the unifying trend is sufficiently intense to paralyse the influence of past separations between "mental" and "physical" labour in the worker's consciousness.

In addition, another kind of separation of workers, their technological specialization, is gradually overcome. The "psychological contents of different labour processes become more and more homogenous: specialization is transferred to the machine, to the instrument of work; but what concerns the differences of experience and the perceptions of workers dealing with different machines, is that they are diminished, and in this higher technology they become negligible in comparison to the amount of similar experience and perception comprising the contents of labour — supervision, control, and management of a machine. Specialization, as a matter of fact, is not abolished by this, — branches of industry in fact are not mixed up, each of them has its own technology — but it is, precisely, *overcome*, it loses its harmful traits, ceases to be a network of partitions between people, which narrows their outlook or confines their communications and mutual understanding"<sup>10</sup>.

What concerns social anarchy, competition, the fight of man against man, resulting from the division of labour, they also lose their fragmentary impact over the working class as it develops, because it is actually eliminated amidst it. Comradely working relationships

and a community of interests in regard to capital give birth to proletarian unification in numerous class organizations, which, step by step, perhaps wavering, but inevitably, lead to its unification into the world collective.

The working class promotes the organization of things by its labour, and the organization of its collective human effort — by its social struggle. It has to arrange the experience of both spheres into a specific ideology — the organization of ideas. Thus, life itself makes it an organizer of the universal type, and the universal organizational point of view — is its natural, and even indispensable, trend.

This is also seen in how easily a worker-specialist liberates himself from professional corporate prejudices, and how avidly the advanced worker strives for encyclopaedic, rather than narrow and specialist knowledge, and how willingly they learn monistic ideas and theories in all realms. However, this does not mean that the new point of view evident in a great number of particular appearances and tremendous in its scope would be recognized easily, and rapidly take its final shape. The industrial proletariat itself is only gradually becoming the new social type, re-educated by the power of life relations formed only recently. Ideology, as a matter of fact, is the most conservative side of social nature; the elaboration of new life conditions, a new understanding of the world, a new culture is the most difficult of the vital tasks of the class.

The great social crisis of recent years should give a powerful impetus to the recognition and formation of the universal organizational point of view. Both the elements of the crisis — a world war and the world revolution called forth by it — in their own ways push the working class in this direction.

The world war itself was the greatest organizational school and gave rise to an unprecedented growth in the organizational capacities of every person, every collective, which participated in it directly or indirectly, and provided them with an unprecedentedly rich experience. This experience is notable both for its extremely precise statement of the task, which one had to fulfil by any means or to die, and the *comprehensiveness* of the task<sup>11</sup>. The unity of the organizational point of view is possessed of enormous power and calls forth an acute need for the unity of organizational methods.

The war was the first stage of the great organizational crisis; it provoked the second stage, revolution. The Revolution has not only compelled the working class to organize its forces hastily and strenuously; it has driven it into a unique situation: in some countries at least it compelled the working class to take over the organization of integrated social life. This situation, regardless of whether it is temporary or final, has substituted the restricted scale of the organizational task of the working class with the universal one. The sharper is the contrast between the character of the task and the shapelessness of organizational experience, its habits and the methods of the working class, the clearer is the necessity of their arrangement, the more urgent is the need of a *universal organizational science*.

Thus all the vital preconditions of this science have appeared. Long and difficult was the way humanity had to travel to get to it. This is an all-human science in the most sublime and full meaning of the word.

Its idea was unavailable to the old classes because of the fractional character of their being and the one-sidedness of their experience. When historical forces had put forward a new class in a new, unifying position, then the time had come for its realization in life,



where it will be both the precursor and a powerful instrument of, the real organization of mankind into a unified collective.

#### § 4. Prototypes of Tektology

Tektology should scientifically and integrally arrange the organizational experience of mankind. As we know, each individual possesses a share of this experience not only in his specialist branch, but also — in scraps and pieces — in a great number of others. This share is somehow arranged by him consciously or, most often, unconsciously, and he is guided by it in the most diverse occasions of his life. To put it in other words, each individual has his, small and imperfect, spontaneously constructed "tektology". In practice and thought he indeliberately operates "tektologically", in a manner, similar to that of the Philistine speaking prose or, in looking at his watch, employing astronomical values without knowledge or intention.

But even this lay tektology should not be considered merely individual. People get, from their social environment, by means of communication with others, the major part of their experience and, especially, the methods of its organization. This part is significant to such an extent that their personal contribution, in comparison to it, represents an immeasurably small and, moreover, *dependent* value. So, even lay tektology has elements common to a mass of people, if not all — or, so to say, conventional elements. They will frequently form the basis of our analysis; and now we will point to the prime and most important of them. This is language, speech.

Speech is an essentially organizational process and, besides, of a *universal* nature. By means of it, all the practices of people in their co-operation are organized: the spoken word establishes common

goals and common means, determines the place and function of each collaborator, outlines the sequence of activities, etc.. Besides this, speech organizes all human knowledge and thought: by means of words experience is transmitted, accumulated and concentrated; its "logical" processing has to do with verbal signs. *Speech is the primary tektological method*, produced by the life of humanity; therefore it is the vivid proof of tektology's possibility.

Let us consider the main facts of the development of speech: the same grammatical roots in innumerable historically formed variations serve as the names of the most diverse phenomena and correlations. How could it be? The answer of the philologists is well-known: by means of real *analogies* between different phenomena or correlations. But many roots are spread along absolutely all spheres of experience. Therefore, the chain of analogies should cover all these branches. We have already given illustrations of such ramifications<sup>12</sup>.

Of course, we should not confuse philology with tektology; we ought not think, that language, even now, can inform the study of organizational relations. No, the way of analogies is often tortuous and difficult, the art of language is spontaneous; and what is close in language is often is very distant from the point of view of tektology, as well as the other way round. Moreover, it is modern language itself with its specialization and lack of common concepts for wholly uniform correlations in different spheres, that will present the major technical obstacles to tektology. But we have to mention, that the tektological trend appeared together with speech, i.e. since man became a thinking being.

The approximation of this trend by scientific forms was expressed in the appearance of philosophy. Philosophy sought to consolidate all human experience, which had been ruptured by the power of

specialization, into a singular scientific and harmonious system; but it did not recognize its dependence on living *practice* and therefore failed to understand that the task can be resolved only on the basis of an objective overcoming of specialization. Until recent times this resolution has been objectively impossible; but philosophy *believed* in it and sought to find it. It intended to *represent* the world as a harmoniously unified system — to "explain" it through some universal principle. In fact, it was necessary to *transform* the world of experience, whatever it might be in reality, into an organized whole; but this cannot be done by philosophy alone, even by cognition in general, without any assistance. This was understood by the greatest thinker of XIX century, Karl Marx, who opposed the philosophical task of "explaining" the world to the real task of its *transformation*.

Since the time of J. Locke, D. Hume and I. Kant, philosophy began to turn into a general methodology of cognition, or "*epistemology*". The nature of the task was understood more correctly, but its size was diminished, which again reflects the impact of specialization. Methods of cognition cannot be explained and integrally organized beyond their connexion with the methods of living practice. Philosophy, developed in this direction, has lost its way in shallow abstractions and degenerated into a new scholasticism.

The first attempt at a *universal* methodology was undertaken by Hegel. He sought to find out, in his *dialectics*, the universal method of the world, understanding in it not a method of organization, but more indefinitely and abstractly — a method of "development". This indefiniteness and abstractness barred the objective success of the attempt; and besides, as a method drawn from the special ideological sphere, from the sphere of cognition, the dialectics by its nature was not sufficiently universal. Nevertheless, this systematization of experience, worked out by Hegel with the help of dialectics

surpassed in its immensity everything, which had been ever done by philosophy before and had a tremendous impact on the further progress of the organization of thought. The universal-evolutionary schemes of H. Spencer and especially materialistic dialectics were the next approximations to the present statement of the question.

This last statement is distinguished, firstly, by its being based on the elucidation of its *organizational* essence, and, secondly, that it is wholly *universal*, embracing both practical and theoretical, as well as deliberate human and spontaneous natural methods. Some are elucidated and explained by the other; and beyond this integral statement of the problem its resolution is impossible, for a part, isolated from the whole, cannot become a whole or be understood without the whole.

We shall call this universal organizational science the "Tektology". The literal translation of this word from the Greek is "the theory of construction". "Construction" is the most general and suitable synonym for the modern concept of "organization".

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<sup>1</sup>Nature "invented" the magnifying glass separately in animals and plants. Our crystalline lens serves for concentration of light on a sensitive eye retina, which perceives the images of things produced by crossing rays. "Luminescent moss" has similar lenses made of transparent cells for the concentration of light on chlorophyll particles, which, by utilizing the energy of light, produce starch for the plant out of carbonic dioxide in combination with water.

<sup>2</sup>Bogdanov is obviously referring to what we would now call electro-magnetic waves — Eds.

<sup>3</sup>Usually logic is defined as the science of the laws of *thinking*. But even the ancient thinkers understood that abstract thinking is a copy of oral discussion — "the speech of the soul with itself about the subjects of its cognition". By the process of logical

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thinking, an individual reaches a compromise with himself, puts in order and coordinates the diverse data of his experience.

<sup>4</sup>For example, "малый" — "small" is the result of division into parts; "молодой" "young" is associated with "small"; "море" — "sea" is notable for the easiness of division of its water; "erde" — "earth" — means primarily soil, which is soft, mellow, and easily disjoined; "schwarz" — "black" — and the Russian "смола", "смоль" ("pitch") are associated with representation of greasing or soiling by a material, which can be ground or diffused, etc..

<sup>5</sup>This is the reason why I have proposed naming the universal organizational science with a word, which has the same grammatical root, "tektology". E. Haeckel had already used the word, although only in reference to the laws of the organization of living beings.

<sup>6</sup>In contrast to English, in Russian the term сочинить ("to compose") can be applied to novels and poems as well as to music — Eds..

<sup>7</sup>М.Голдштейн, "Основы философии химии", (M. Goldstein, "Elements of the philosophy of chemistry").- St. Ptsb., 1902, p.57-58.

<sup>8</sup>M. Goldstein., *ibid.*, p. 123.

<sup>9</sup>A. Poincare , La valeur de la science. Paris, 1905, p. 146.

<sup>10</sup>А.А. Богданов, И.И. Степанов, "Коллективистический строй" // Курс политической экономии (А.А. Богданов, И.И. Степанов. "Collectivist system" // Course of political economy) Vol.II. Issue 4, Petrograd — Moscow: Communist, 1923.

<sup>11</sup>See "Preface" to the first edition of the second part of "Tektology" (reproduced in this edition).

<sup>12</sup>See details in: А.А. Богданов, "Наука об общественном сознании" (А.А. Богданов, "Science of public consciousness"). Moscow, 1914, pp. 56-58, 63-65.

# Chapter II

## Basic concepts and methods

### A. ORGANIZEDNESS AND DE-ORGANIZEDNESS<sup>1</sup>

#### § 1. Organized Complexes

The first attempts to explicate the concept of organization led to the idea of *expediency*. The concept of organization referred then, of course, only to living beings, and such research would proceed with the concept of the individual organism as its starting point. The expedient construction of its different parts and their expedient interconnexion were not only evident but, on further investigation, manifested themselves more fully and clearly, and with startling perfection.

The idea of expediency<sup>2</sup> contains an idea of purpose. Any organism and any organization have their own "purposes" to which they "conform". However, the existence of a purpose implies the existence of someone who establishes and implements it, a consciously acting being, the Constructor, the Organizer. Who, exactly, prescribed those purposes to the organisms of man, animals, or plants, which are attained via their vital functions? Who

established organs and tissues in conformity with these functions? These questions, that seem quite natural to common reason, immediately deprive research of any scientific character; and turn cognitive efforts toward the realm of metaphysics and religion, ultimately leading to the acceptance of an idea of a personal creator or God. The priests of all religions, Christian and non-Christian, are still using the argument of the "expedient" organization of living beings as the basis for their "apologetics", that is, the theoretical defence of religion.

However, the development of science has shown that the interrelations expressed by the term expediency could emerge and evolve in quite a natural way, without any "subject" who consciously posit purposes; that there is an *objective* expediency in nature. Expediency is the result of the universal struggle of organizational forms, a struggle in which "inexpedient" and "less expedient" forms are destroyed and disappear, and the "more expedient" forms are preserved — the process of natural selection. The very concept of expediency turns out to be no more than an analogy or metaphor which might cause confusion. Clearly, it is unsuitable for the scientific definition of organization.

Attempts to define organizedness formally, as harmony or a correspondence of the parts between themselves and with the whole, also fails to settle the problem; it is just a substitution of the term "organizedness" with its synonyms. What we really need is an elucidation of what this correspondence or harmony implies. Otherwise it is quite useless replacing one label with another.

For a long time biologists have been describing organisms as "wholes which are greater than the sum of their parts". However, they hardly ever perceive this formula as an exact definition, especially because it looks like a somewhat superficial paradox.

Nevertheless some of its features are worth special attention. It neither includes a fetish — the subject prescribing the purposes, nor reduces to a tautology, i.e. to repeating the same thing in different words. And its contradiction of formal logic, whether seeming or real, means nothing by itself, for the limitations of the latter have been well established by modern scientific and philosophical thought.

What, in fact, do the words "an organism is a whole which is greater than the sum of its parts" imply? In what sense or respect is it greater than this sum? Undoubtedly the question concerns the viability of the organism, its ability to struggle against the environment. Being de-integrated, the parts of any complex organism have a viability either infinitesimally small, or diminished to such a degree, that the sum of its quantities, if one could calculate it, would certainly be far less than the corresponding quantity of the living whole. The body lacking an arm, and the arm cut off from it, provide a sufficient illustration. However, investigation of the problem in the case of such complex systems as the organism, and such relative and hardly measurable magnitudes as viability, is the most difficult; it is better to begin with simpler cases.

Such as, for example, elementary co-operation. Already the joining of identical labour efforts on some mechanical task may result in the growth of a practical outcome in greater proportion than the sum total of these labour efforts. If the task is, for instance, to clear a field of stones, bushes and roots, and if one man is able to clear one dessiatine<sup>3</sup> a day, then two men together can, during one day, do more than double the task, 2.25 - 2.5 dessiatines. In the case of 3 or 4 workers the relationship may be even better, up to a limit, of course. But there is another possibility, that 2, 3 or 4 workers may, together, do less work than two, three or four times that of one. Both cases depend completely on the mode of the combination of



their efforts. In the first case, it is quite correct to assert 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. This first case is designated as *organizedness*, the second as *de-organizedness*.

Thus, the essence of these concepts is a *combination of activities treated from its practical side*; and to make clearer the thesis about the whole which being either greater or smaller than the sum of its parts one should add to it the word "practically". Then it becomes a simple expression of self-evident and unquestionable fact. Nevertheless, it remains to some extent logically paradoxical, at least to average contemporary thinking. One can easily imagine how the combination of activities may decrease their practical sum. This occurs when activities counteract each other; where they completely or partly paralyse or eliminate each other, or, in short, mutually "de-organize" each other. But how can magnitudes be joined so as to *increase* their practical sum? At first sight it looks like the creation of something out of nothing.

In fact the riddle is easily solved; we need only relate the activities being organized to the *resistances* which are to be overcome. How can two workers together clear the field not twice but, say, 2.5 times faster than one worker? In response, an economist would note the following points: firstly, the very conjointness of work produces a revitalizing, encouraging influence on the nervous system of the worker and thereby increases the intensity of his work; secondly, the combination of the efforts of two workers makes it possible to overcome obstacles which one worker alone cannot; and for many obstacles which are hard, though not insurmountable for one worker, to be got over much faster. Let us consider both of these points, leading off with the second as it is more easily analysed.

Let the physical strength of each of two workers enable him to lift and move a stone of 5 poods<sup>4</sup> weight and no more. Two workers can cope with a stone not, of course, of 10 poods but somewhat less, as it is impossible to combine efforts without some loss, that is, without some mutual hindrance. *This* sum is always less than the result of simple addition; let it be equal to 9 poods. Under the assumptions given, a stone of 8 poods would constitute a resistance either insuperable for a single worker or enough to force him to change his method of doing the job, and consequently, to a considerable additional expenditure of energy and loss of time, e.g. for breaking the stone with a hammer or constructing a lever to move it away. The co-ordination of the efforts of two workers removes this insurmountability or the need to change methods. If the stone is lighter than 5 poods, but close to this limit, then a single worker must apply the greatest effort to move it, thus completely exhausting his forces and taking much more time; while for two workers this weight is far below their limit and a medium effort is enough for them to move it quickly away.

The resistances are constant here. But resistances can alter depending on the conditions of co-operation. For example, let two workers have to lift themselves out of a well. A large tub, a rope and a pulley are used for lifting, the tub being at the bottom of the well together with both ends of the rope. The weight of the tub is 40 kg, each worker weighs 70 kg and can pull the rope with a force of 100 kg. It means that neither of them can lift himself separately: their specific activeness is 100 kg and the resistance is  $40+70=110$  (kg). Together they are able to lift a weight of a little less than 200 kg, say, 180 kg. Then, if they co-operate they will be able to lift themselves because the total weight is  $40+70+70$ , i.e. 180 (kg). The resistances are partially summed, but the other part of them remains an invariable common magnitude; and although the summation of activities is not perfect, it nevertheless exceeds the partial summation

of resistances (in the first case the empirical sum of available activities is  $180/100$ , i.e. 1.8 times greater than that of either of the two workers, in the second it is  $180/110$ , i.e. approximately 1.64 times greater than that of the original load).

As far as the "psychological" influence of co-operation is concerned, it appertains to the *internal* resistances of the organism. The worker, when he is labouring alone, undertakes and carries out all actions on his own initiative and his own stimuli. He has to appropriately tune his nervous and muscular apparatus for each action quite independently; while in a joint effort this adaptation process goes on to a large degree due to imitation, i.e. in a much more mechanical and automatic way, thus decreasing considerably the inner resistances of the organism of the imitator. The stimulating influence of the apparent success of the efforts also helps to lower internal resistances, etc.

In general, as we see, the matter reduces to a relationship between the activities which are being organized and the resistances confronting them. Activities which are being organized do not combine without losses, their practical sum, taken by itself, is less than their precise numerical sum: 5 poods and 5 poods have made 8 poods in the case above. But resistances either do not add up at all — the stone of eight poods has the same weight for one worker or for two workers, or, if they do add up, they do it less perfectly than the activities which are being organized. The latter case can be observed for those internal resistances of the organism which are related to changes in the direction of efforts: if for the independent transition of each worker from one action to another this resistance is  $a$ , then for two workers together it is not  $2a$  because imitation is involved here and for the one who follows the example of the other, this magnitude turns out to be considerably smaller;  $a+a$  produce a practical sum of, say,  $1.5a$  <sup>5</sup>.

However, the problem is not always like those above: which kind of addition is more perfect, which of the two sums is closer to the mathematical. It is possible that specific resistances add up to a full sum and specific activities to only a partial one, and still organizedness can exist. Imagine a mother and her baby needing to move from one place to another. The baby cannot walk, and therefore his specific activeness in respect to this objective equals to zero; while the resistance, i.e. the mass of his body, amounts to a tangible quantity. The mother's specific activeness amounts to a magnitude exceeding the resistance. For instance, the first may be expressed by a coefficient 100 and the second by 60; i.e. if the mother weighs 60 kg then these coefficients mean that she would be able to walk the required distance even if her weight grew to 100 kg. Suppose the baby weighs 10 kg. So, she sets out with her baby in her arms. The objective result exceeds that which one could obtain lacking the linkage of these two beings: both are set in motion, and not the mother alone as would happen in the other case. And what do our summations come to? Specific activities are  $100 + 0$  — in fact, this sum is slightly less than 100, because the baby with his weight not only makes the mother work harder but also hampers her motions, hindering her normal body position during a walk and distracting her attention. So, let this sum be equal to 95. Contrariwise, the specific resistances, i.e. weight or mass, add up without losses:  $60 + 10 = 70$ . Nevertheless, 95 is more than 70, and the relationship manifests the characteristics of organizedness.

Thus, in reality the organized whole turned out to be practically greater than the sum of its parts, not because new activities were created within it out of nothing, but because its available activities were combined more successfully than the opposing resistances. Our world is generally *a world of differences*; only differences in energy tensions display themselves in action, and only they have a practical meaning. Where activities and resistances collide, the practical sum

embodied in the actual results depends on the mode of combination. For the whole this sum increases in those cases where combination is more perfect or "harmonious", contains fewer "contradictions". It is this case which characterizes a higher level of organizedness.

An illustration from another field is the symbiosis of *Vorticella*, a unicellular infusorian, and *Zoochlorella*, a unicellular alga living inside it. The first is the simplest of animals; it absorbs oxygen and discharges carbon dioxide. The second is the simplest of plants and contains green seeds of chlorophyll; it decomposes carbon dioxide at the expense of the energy of the sun's rays using carbon as a material for its tissues, and discharges oxygen. Thus, a certain part of their activeness in the material form of this or that substance, lost by one participant in the symbioses as a useless waste, is directly acquired by the other, and vice versa; consequently, it is preserved within the symbiotic whole. It is clear that this whole has at its practical disposal a greater sum of activities than its parts would have had separately: it is a pattern of a widespread type of organizational relation.

An elementary illustration from the non-organic world: a million small crystalline particles weighing together 1 g could easily be dispersed into space by a slight breath of wind; but if they are bound into a single crystal, the same test would produce only a slight vibration.

## **§ 2. Activities-Resistances, and the Types of their Combinations**

Organizational research is seen to treat quite identically human activities or "energies", and other activities or energies, inherent in other living beings and, lastly, in the non-organic natural processes.

In its genesis the notion of "generalized activeness", or "energy" is rooted precisely in human activeness<sup>6</sup>. It was the first to become the subject of thought: the words of primordial language and, consequently, its primary notions expressed labour actions. The notion of "activeness" is applied to animals only so far as they are thought about as if they were human beings. The notion of "work", as well as the more general and abstract notion of "energy" is applied to spontaneous natural phenomena only because, as our experience has proved, they cause in various complexes decomposing or combinative changes of the same kind as those achieved by human effort.

One should not understand this in the sense that the spontaneous activeness of nature is identified with the human, as a naive savage would think. Scientific cognition always keeps in mind a vital distinction between them. But even science — consciously or unconsciously — took and modified the notion of labour effort as the starting point of the development of a generalized notion of energy. In Russian the term "работа" ("work") has an intermediate meaning: only man "labours" ("трудиться"), whereas "work" may be used with regard to cattle, machines, or the force of the wind, with mechanical actions being meant throughout. As to the notion of "energy", it comprises mechanical work as well as all those processes which can turn into, or result from, it, and, as such, are thereby equivalent to it, like thermal, chemical and other processes.

Whatever the activeness, whether decomposing or combinative, being directed at a certain complex, it inevitably encounters there a *resistance* which may be high or low. This resistance is measured by the sum of effort or, generally, by the total energy, spent to overcome it. It provides us with a characteristic of the complexes themselves, as it depends on their *composition*, i.e. the elements they are built of, and on their *structure*, i.e. the relationships between

these elements. For example, the resistance to our intervention offered by the organism of an animal or plant is determined by the characteristics of its organs and tissues, as well as the relationships between them. The resistance of mental associations to cognitive analysis and synthesis is conditioned by the stuff of underlying ideas, as well as the nature of the associative combination of these ideas, the form and durability of their connexion.

However, the notion of "resistance" is not something special and independent; it is just the same *activeness* but viewed from a different point of view, one opposed to other activenesses. When two men are wrestling, the activeness of one man is a resistance to the other, and vice versa. Likewise, if two armies or two classes are fighting between themselves, one side's activities are resistances to the other; it depends only on the reference point of the observer. From a hunter's point of view, or the viewpoint of an observer taking him for the centre of observed evidence, the hunter's efforts are activities, and efforts of all animals which he is hunting are resistances. At the same time if one focuses on the description of an animal striving for its life, then its efforts realize the activities of its organism. In the past there existed a conception of sheer passive resistance or "inertia" which in itself is not an activeness but which confronts activeness. This conception was, however, demolished with the progress of science. The inertia of matter embodied in its "mass" has turned out to be a manifestation of the energy concentrated in it, namely, electrical. "Inertial" atoms are now regarded as the field of the most intensive processes in the Universe. Thus, the categories "activeness" and "resistance" are not only entirely correlative but also reversible: every activity is a resistance to the activities which it confronts, and vice versa.

In this sense there are no principal differences in nature: between living and non-living, conscious and spontaneous, etc. The elements

of any organization or complex, studied within the organizational framework, are reduced to *activities-resistances*.

The very notion of an "element" is entirely relative and conventional from the standpoint of organizational science: elements are merely parts into which the object under study is required to be decomposed according to research goals. Those parts may be as great or as small as is wished, they may be further divisible or indivisible — analysis can not be constrained by any limits here. One has to take gigantic suns and nebulae as elements of star systems; enterprises and individuals — as elements of society; cells — as elements of organisms; molecules, or atoms, or electrons — as elements of a physical body depending on the problem settled upon; ideas, concepts — as elements of a theoretical system; notions and impulses of will — as elements of mental associations, and so on. But whenever research makes it necessary to further decompose, either practically or mentally, any of those elements, they become "complex", that is, a combination, the result of the connexion of next order elements, etc.

Any decomposition into elements, be it really done or only thought of, is, of course, de-organization. But this is precisely why decomposition is done, namely, to decrease the resistances of things to our efforts to re-organize them into new, and for us, more desirable combinations. *De-organized wholes are practically less than the sum of their parts* — this formulation obviously follows from the previous one.

Regarding the example from the field of labour co-operation I have mentioned that the total labour force of two workers may turn out to be less than the sum of their individual labour forces. This is exactly the case of de-organization: the two workers don't help, but hamper each other. In certain combinations their efforts may be



completely paralyzed, such as when they pull the same rope in opposite directions, a child's push would set the whole system in motion. Meanwhile, if their forces amount to, say, 10 and 9 poods, then the practical sum determining the motion of the system equals 1 pood instead of 19.

It should be noted, that complete, ideal organizedness does not exist in nature; de-organization is always mixed with it in some proportion. For example, even the best arranged co-operation can not be free of some, at least minimal, internal hindrances and unco-ordination; the best designed machine [cannot be totally free] — of detrimental friction, and so forth. Sometimes one can observe all the transitional steps from the highest organizedness to ultimate de-organization in one and the same system, as happens, for instance, during a steadily developing quarrel between close collaborators or spouses.

As is known, a natural magnet is a piece of special ore — magnetite. A magnet can be substantially reinforced by combining it with a soft iron shell, although soft iron itself is not magnetic, or, more precisely, shows practically infinitesimal active magnetism. This famous example of "non-organic" organization is scientifically explained as follows. Iron particles are magnets by themselves but inside a piece of a soft iron they are situated in full disorder, being turned in all possible directions, and their magnetic effects in this chaos are mutually eliminated. However, when they are placed in a strong enough magnetic field, that is, in an area of considerable magnetic influence with one certain direction, they turn, being "oriented" along the force line of the field, and their own effects do not completely eliminate each other but add up; the entire shell becomes actively magnetic itself, thus reinforcing the core magnet. This case also demonstrates that given a more perfect summation of activities, they cease to be mutually resistant. At the same time, if

one connects two fully equivalent bar magnets, opposite poles together, their magnetic effects are mutually paralyzed, the practical sum being close to zero; this is a de-organized magnetic system.

The third type: a complex comprising several persons, who are neither involved in any collaboration, nor mutually hostile, that is, they are "mutually neutral", generally possesses exactly that amount of force, or activity-resistance, which equals the sum of these persons' separate forces. Under ordinary conditions the gases of the air are mutually physically neutral; the height of a mercury column needed to counterbalance their joint pressure equals the sum of those of those mercury columns, each corresponding to the partial pressure of oxygen, nitrogen, carbon dioxide, water vapour, argon, etc. The weight of a sack of potatoes, or the sack's resistance to the effort of the one who is lifting it, is the exact sum of the weights of the individual spuds and the sack.

Complexes of the first type I call *organized*, complexes of the second type — *de-organized*, those of the third type — *neutral*.

The concept of "de-organizedness", as well as that of "organizedness" has been sufficiently ascertained. Still, how should one understand the third type — "neutral" complexes? If neither mutual reinforcing nor mutual weakening of activities is observed, then the simplest assumption is that there is no interaction at all between the elements. This conjecture would, however, contradict the entire foundation of the modern scientific world-view, according to which everything is interrelated, all things influence, and interact with, each other.

Thereby, one may further assume that the elements of a neutral complex have effects on each other too negligible for our methods of perception and measurement. For instance, according to the law of gravity the weight of a sack of potatoes must not be exactly equal

to the sum of the separately measured weights of each spud and the sack; their mutual attraction alters, depending upon their spatial situation, this sum. However, the difference is beyond the limit of the sensitivity of present day measurement technology.

However, this assumption does not solve the problem; sometimes it is even inapplicable. For instance, if a crystal of some salt is placed into a saturated solution of the same salt, then the complex seems to be chemically and physically neutral: both its parts, the liquid and the solid, preserve their properties, and therefore, with respect to these properties, the whole is a mere sum of its parts. Nevertheless, one cannot call this crystal - solution interaction negligible or infinitesimal; it is considerable and can be demonstrated using existing techniques; but this interaction is *bilateral* by nature. The solution dissolves the crystal taking away its particles, and at the same time becomes through this process oversaturated, the solution deposits an equal quantity of particles onto the crystal. Thus, the crystal is exposed to *parallel* de-organizing and organizing effects of the solution, and the latter, in its turn, is exposed to those of the crystal. *The equality of organizing and de-organizing effects leads to a neutral interconnexion of the complex.*

This is an application in tektology of the idea of *dynamic equilibrium* customary to all the exact sciences. If no visible change is observed, one would assume the presence of two equal and opposite tendencies mutually disguising one another. For instance, the maintenance of a living organism results from the equality of the processes of assimilation and de-assimilation in the metabolism of substances and energy; the maintenance of the shape of a waterfall is owed to the equality of the inflow and outflow of water, etc.

Interference in an electrical, light, air, or any other wave provides a vivid scientific illustration of the three basic cases discussed. A

spatial superposition of waves may intensify or weaken them. Let two identical light waves propagate so that one's rise exactly coincides with that of the other, and so does the fall, then the light intensity perceived in total is not double but fourfold:  $1+1$  equals 4. Contrariwise, if the rise of one wave fully merges with the fall of another, and inversely, then two lights together yield darkness:  $1+1$  equals zero. All intermediate cases fall in the range between these limits, that of organizedness and that of de-organization, including that ideal medium case of the exact equality of total light intensity to arithmetical sum:  $1+1=2$ . It is that very case when the rise of one wave coincides by half with the fall of another wave. In such a case the relationships of organizedness and de-organization are mutually balanced, and the combination obtained

As is seen, only if the opposite tektological tendencies are balanced is the sacred formula of common sense — "twice two is four" — actually carried out. However, this limitation is not an obstacle for it to be approximately true in many cases, for organizing and de-organizing processes are always interlaced in our experience, but, it should be stressed, they are only *approximately* true. This formula is quite exact only for the ultimate, ideal combination; deviations from it are found to be the more inevitable the more perfect the available research methods. Were analysis precise enough, no case would be rigorously consistent with this formula.

Certainly, one may insist that two persons and two other persons always amount to precisely four persons, no more and no less. However, this formulation is fundamentally inexact and conventional: really different and unequal complexes — individuals — are viewed as exactly equal mathematical units, that is, the very formulation throws aside all inequalities and differences beforehand. Its arbitrariness will be clear enough, if we ask whether two women

and two unicellular embryos at the initial stage of development inside their organisms are really four persons.

Theory exists to inform practice, calculus should be useful for actual calculations. Though people recruited for military service are comparatively uniform in strength and endurance, still their number is not yet a sufficient datum by itself for military calculations, even approximate ones. The experience gained in the French colonial wars in Northern Africa evidences that, being equally armed, an average Arabian soldier in a one-to-one clash is just as good as an average French soldier, but a detachment of 200 French soldiers is stronger than 300 - 400 Arabian fighting men; and a troop of 10 thousand Frenchmen would defeat a native army of 30 - 40 thousand men. The European tactics are more perfect in adding people's combat forces, mathematical calculation being refuted in practice; though it surely remains useful and necessary as a first approximation for practical calculations.

In other cases the first approximation would be quite sufficient for the ordinary needs of life, or even rather exact in general. Anywhere one succeeded in having defined and implemented it, its practical organizing significance proved to be enormous. Such is the vital meaning of mathematics; without it, neither scientific technology nor the whole of the modern production and market systems nor the planned waging of modern warfare would be possible .

It is easy to understand that there is a special relationship, a profound affinity between mathematics and tektology. Mathematical laws do not refer to a particular *area* of natural phenomena, as the laws of the other, special, sciences do, but to each and all phenomena, considered merely in their quantitative aspect; mathematics is in its own way universal, like tektology.

For thought raised on specialization the most potent objection to the possibility of a universal organizational science is precisely its universality. Is it ever possible that the same laws be applicable to the combination of astronomic worlds and those of biological cells, of living people and the waves of the ether, of scientific ideas and quanta of energy?.. Mathematics provide a resolute and irrefutable answer: yes, it is undoubtedly possible, for such is indeed the case. Two and two homogenous separate elements amount to four such elements, be they astronomic systems or mental images, electrons or workers; numerical structures are indifferent to any element, there is no place here for specificity.

At the same time mathematics is not tektology, it lacks the very notion of organization. If so, what then is mathematics?

It is commonly defined as a "science of quantities". But quantity is a result of measurement, and measurement means consecutively applying some standard to the object measured and obviously presupposes that *a whole is equal to the sum of its parts*. To measure a phenomenon or to treat it as a quantity, i.e. mathematically, simply means to consider it as a whole being equal to the sum of its parts, as a *neutral complex*. And we have ascertained that a neutral complex is one with its organizing and de-organizing processes being mutually balanced.

So mathematics is merely a *tektology of neutral complexes*, a part of the universal organizational science having evolved earlier than the others. So far it has managed without the concepts of organization and de-organization because it proceeds from combinations in which both this and that activity mutually eliminate or, rather, paralyze one another.

Two divisions are distinguished in all natural sciences — "statics" which deals with forms in equilibrium, and "dynamics" which deals

with the same forms, as well as their motion, in the process of change. For example, the anatomy and histology of organisms is their statics, physiology is their dynamics. Statics always evolves earlier than dynamics, the former being then reconstructed under the influence of the latter. The relationship between mathematics and tektology is seen to be similar: one represents the standpoint of organizational statics and the other — that of organizational dynamics. The latter standpoint is the more general, for equilibrium is only a particular case of motion, and in essence, is just an ideal case resulting from changes which are completely equal but quite opposite in direction.

Needless to say, mathematics studies the change of quantities as well, but does not touch upon the organizational forms of the processes which the quantities refer to; these forms are supposed static, invariable, and a new quantity, resulting from any such change, is just another neutral complex equal to the mere sum of its parts. Mathematical analysis embraces also those cases, in which quantities mutually eliminate each other, fully or partly, that is, which combine in the de-organizing sense, as positive and negative magnitudes or as vectors do; but this is a mutual de-organization of quantities leading to new quantities — from neutral complexes to other neutral complexes<sup>7</sup>. Hence this mathematical dynamics is not organizational, it is irrelevant to the transformation of organizational forms.

So the initial basic concepts of tektology are those of elements and their combinations. Elements are activities-resistances of all possible kinds. Combinations boil down to three types: organized, de-organized, and neutral complexes. They vary in the magnitude of the practical sum of their elements.

### §3. The Relativity of Organizational Concepts

Studying various complexes leads to the conclusion that tektology supports, in addition, another principle of the exact sciences, namely the idea of *relativity*. A system is organized, not generally or universally, but only in regard to certain activities, resistances or energies; at the same time in regard to others it may well be de-organized or neutral.

A complex formed by a number of workers at some factory is a highly organized system in relation to the technological process. However, if they stick to different positions on the issues of upholding their interests and rights, the same system will be quite de-organized in its economic and political practices. Finally, in the sphere of consumption this complex is approximately neutral; in this case mutual influences are weak and their outcome is hardly perceptible. A machine is an organized complex regarding its special functions or those material resistances it is designed for; but regarding any other forces it is neutral or de-organized. Its weight is the exact sum of the weights of its parts; and even the slightest disturbance may often destroy it, if this disturbance is of a kind for which it is not adjusted; as, for example, a grain of sand getting into its ingenious and necessary parts. Some alloys being more resistant to flexing, stretching, and twisting than their constituent metals, are, on the contrary, more easily affected by an increase of temperature, i.e. they have a lower melting point.

However, in life and the social sciences the notion "organizedness" is used mostly in a vague and irrespective sense, as "organizedness in general", the concept itself being usually substituted for quite a different one which is far from coincidence with the former. When



speaking about highly or lowly organized plants, animals, collectives one has in mind their complexity and the differentiation of their parts. But it is obviously possible that complexes of high complexity and differentiation of parts are at the same time extremely de-organized. What then is this vital "organizedness in general" really correlative to?

It is correlative to the ordinary influences of the *environment* — its activities and resistances. It is this environment which is meant, at least unconsciously, in such formulations; one accepts it as something well-known and equal for all living beings, this premise has only to be realized and formulated to see that it is wrong. An organism or collective is considered as highly organized if it is able to get over a number of various activities-resistances inherent in its normal environment. In many cases exact investigation has to break down this uncertain organizedness into particular, specific kinds, each relating to certain activities and resistances.

Studying the forms and methods of organization one is bound to take into account yet another relativity. History shows that in the development of mankind, as its social nature and the organization of its practices and thinking were changing, the organization of the universe as a whole, and of its individual complexes also changed. In the age of the early patriarchal mode of life every thing of the organic or non-organic world was attributed the highest degree of organizedness which is expressed by the notion of the "soul". Long after that the world of heavenly bodies was still conceived as a system organized according to a plan and the heavenly bodies themselves — as authoritative living beings. Later any organizedness outside the scope of living phenomena ceased to be seen; concerning especially the "soul" or the psyche Descartes refused to allow them even to beasts. Now organizedness is found again, for example, in

the crystallization process; as for me, having made this notion more exact and distinct, I have to declare it universal.

Similar distinctions exist within the same age, too. For instance, even presently plasmodium is considered a mere slime, something extremely de-organized to the ignorant person; for the biologist, however, it is a colony of living cells with nuclei, complex reproduction, nutrition and respiration functions, etc. Likewise, a person familiar with the design of an ingenious machine perceives it as a complex and highly organized system; while for the savage it is a heap of metal pieces and plates, or a living being when he is watching it in action.

This is the *social-historical relativity* of the concept of organizedness.

## **B. METHODS OF TEKTOLOGY**

The methods of any science are first and foremost determined by its aims. The aim of tektology is to systematize *organizational experience*; this science is clearly *empirical* and should draw its conclusions by way of *induction*.

Tektology must discover what modes of organization are observed in nature and human activities; then generalize and systemize these modes; further it should explain them, that is, elaborate abstract schemes of their tendencies and regularities; finally, based on these schemes it must determine the directions of organizational modes development and elucidate their role in the economy of world processes. This general plan is similar to the plan of any other

science but the object studied differs essentially. Tektology deals with the organizational experience not of some particular branch but with that of all of them in the aggregate; to put it in other words, tektology embraces the material of all the other sciences, as well as of all the vital practices from which those sciences arose, but considers this material only in respect of methods, i.e. everywhere it takes an interest in the mode of the organization of this material.

However, enormous and unique difficulties emerge from this richness of content. Thus, generalization must appreciate the infinite variety of facts which often refer to the most dissimilar areas, it must seek the unity of organizational devices where it is concealed by the ultimate differences of the elements to which they are applied. One has to overcome, too, the force of habit impelling us to liken cognitively only things similar in their very material, by the direct sensations we get from them; and the deeply rooted prejudices of specialization for which collating and comparing heterogeneous materials looks either like a logical gap or an unfruitful game of the imagination.

Fortunately, as we have seen, there exists a science, moreover the most rigid and exact science of all, which clearly evidences by its own example that there are no limits to comparing theoretically empirical data, that there is no heterogeneity which makes it impossible or nonsensical as such. This is mathematics. It takes all and any phenomena as quantities and subordinates them to one and the same formula. If an algebraic scheme, e.g. equation, involves quantities 2, 5, 10,  $x$ ,  $a$ ,  $b$ , etc., they may equally designate the number of human individuals, or star worlds, or atoms, or seconds of time, or units of length, or units of weight, or oscillations in the ether, or images of consciousness — of any numerically groupable set of elements. And whatever the elements chosen, their numerical characteristics remain the same. Mathematics *abstracts* from all the

particular properties of the elements hidden behind its schemata. This is achieved by mathematics with the help of indifferent symbols, like numbers or letters.

Tektology must do likewise. Its generalizations should abstract from the concreteness of elements whose organizational relationships they express, and conceal this concreteness behind indifferent symbols.

It should therewith be remembered that as mathematics studies neutral complexes, mathematical thinking is an *organizational* process and hence its methods, as well as the methods of all other sciences and those of any practice, fall within the province of a general tektology. Tektology is a unique science which must not only work out its own methods by itself but must study them as well; therefore it is *the completion of the cycle of sciences*.

Developing an appropriate symbolics is one of the first and perhaps the most difficult steps towards establishing tektology, and also one of the main prerequisites of success. The history of mathematics clearly enables us to come to such a conclusion. However, tektology faces more difficulties because it considers phenomena more comprehensively and takes account of more complexity.

Tektology must study the various complexes from the viewpoint of their organizedness and de-organizedness. Since the latter are functions which always relate to certain activities and resistances, one should first determine as exactly as possible to which of them these functions relate in the case under consideration. Then a researcher must expediently decompose those complexes into elements. This decomposition may be done in vastly different ways. For example, a living organism can be treated as consisting of the definite tissues or cells; further, as built up from organic or non-organic compounds, like proteins, fats, salts, water and so on; or from a set of chemical "elements" — carbon, oxygen, nitrogen, etc.

Some other ways of decomposition are possible as well, for instance, into "properties", "sensual elements", etc. Every time one must choose, of all these ways, that one which fits the task in hand.

Assume that we want to ascertain how much the living body is organized from the viewpoint of its direct resistance to external mechanical influences. Then we need not decompose this body into chemical elements, or even into biological cells: it will be enough to approach its tissues as physical complexes, to take into account their form, solidity, elasticity, etc. But if the so-called "physical strength" of the organism is concerned, that is the degree to which its activities are organized for carrying out external mechanical work, then the elements would be not only the physical properties of the various tissues — muscles, tendons, bones, chords, but also the chemical ones, for instance, alterations in the contractive substance of the muscles, the functional changes of nervous tissue and so on.

As long as we are clarifying in this manner the particular relationships between systematically determined elements our research does not formally fall outside the scope of a special science; it is physiology for both our examples. But by doing so we have introduced into its methods a tektological insight and have sought consciously for terms and means of organizing those elements in regard to the activities and resistances given. In order to shift to the field of tektology proper one must abstract elements from their specific physiological properties, substitute these elements by indifferent symbols, and represent their relationships in an abstract scheme. This scheme we shall compare with other similarly obtained schemes and thus elaborate *tektological generalizations* giving an idea of *forms and types of organization*: this is the inductive way of research.

Induction exhibits three basic forms: *generalizing-descriptive*, *statistical*, and *abstract-analytical*. They are all, to be sure, applicable to the phenomena of organization and de-organization.

As far as generalized descriptions are concerned, one can notice in advance that in an organizational science they should be inclined to "abstraction" to a much greater extent than those of the special sciences. To cover the relationships of all kinds of elements the description of organizational facts should, as I have just pointed out, abstract from any elements; while the descriptions implemented by the special sciences always have in mind these or other definite elements and cannot abstract from them. For example, even the most sweeping of those sciences — physical chemistry investigates the relations of "bodies" and "physical things": its descriptions always define these "bodies" and "things", their relations and combinations; but these descriptions say nothing about, for instance, notions in the human mind or ideas in a human society, together with their relations and combinations. As to tektology, it always aims to transcend these limits; and generalizations meet its requirements only when they represent equally relationships and combinations of bodies as well as notions, ideas, etc. For tektology, as for mathematics, which is the part of the former which evolved first, all phenomena are equal, all elements are indifferent. Those few generalizations of experience from which mathematics proceeds are universally general and ultimately abstract. Undoubtedly, a tektology of organized and de-organized complexes is bound to develop far more generalizations than a "tektology of neutral combinations", i.e. mathematics, but of the same kind. Their development is the most durable and difficult process, inevitably including several stages at which generalization is still associated with these or other elements, as it is in the special sciences; the difference is that tektology from the very beginning pursues the aim

of removing this limitation, to work out a formulation which would fit all other elements as well.

Statistical methods include, as is known, quantitative enumeration of phenomena and the calculation of their recurrence. Quantitative enumeration is evidently implied by the very definition of "organizedness" and "de-organization": only after it has been performed, even approximately, may one say whether a whole is really greater or smaller in a certain respect than the simple sum of its parts, and to what extent. While calculating how often these or other combinations are reiterated should supposedly be of importance chiefly at the early stages of research, the latter remains within the group of particular, specific facts. It would be strange and hardly expedient to calculate the frequency of, for instance, the centralistic organizational pattern among the structures of non-organic systems, living beings and psychological complexes, social and ideological groups, and so forth. However, approximate evaluations, implying the search for extremely high or low frequencies of certain combinations, may be of importance in this case, too.

The highest levels of research are achieved by means of the abstract analytical method. It establishes the *basic laws* of phenomena, expressing their steady tendencies. The means used is "abstraction", that is the subtraction or removal of complicating features; it reveals the core of those phenomena in its pure form, i.e. precisely that steady trend which is hidden behind their visible complexity. Sometimes abstraction is carried out really as in the case of the exact "experiments" of the natural sciences; sometimes — only ideally, or mentally; this is what the social sciences have usually to confine themselves to. For example, when physicists were investigating the conversion of mechanical motion into heat, they endeavoured to exclude by means of special devices any uncontrolled loss of

produced heat, as well as any accidental heat inflow from without; or, what is equivalent, they tried to reach the perfect balance between this loss and this inflow. By this expedient they reproduced the phenomenon "in a pure form", that is, they practically simplified it by releasing it from any complicating features, and made its core observable, of course, in the scientific and not the metaphysical sense, and discovered its regularity: the definite amount of mechanical motion that is converted to the definite, and strictly proportional to it, amount of heat.

Likewise, when chemists look for regularities in reactions between substances, they endeavour to get the substances being investigated in their pure states. Chemists "abstract" them practically from any impurities by means of various processes of decomposition, or "analysis", and causing reactions between these "abstracted" substances exclude or neutralize systematically all accessory features which obscure the core of the phenomenon, e.g. the withdrawal of gaseous by-products from the scope of observation, and so on. The example of chemistry makes fairly evident why the method of abstraction is also called "analytical": its essence is precisely the decomposition, the analysis of complicated objects, and working with simplified objects and simplified conditions as the result of this analysis.

One can readily see that the position of the astronomers differs from that of the physicists and chemists. Observing the tangled motion of a planet or a comet in the firmament they lack the possibility of practically analyzing this motion, to simplify it in reality, to exclude such complicating circumstances as, say, the motion of the Earth itself together with its observatories or the perturbations caused by the attraction of a number of other cosmic bodies or the non-uniform refraction of rays in the atmosphere, and so on. Nevertheless, for their research to be anywhere near exact in this



case, one cannot manage without simplification and abstraction. So, they are implemented, though not in real experiments but mentally. One by one the attendant circumstances are removed from the estimations and computations until the core of the phenomenon being investigated remains — the planetary or cometary orbit about the system's centre which is, usually, the Sun in our case. The very beginning of modern astronomy originated in the powerful effort of the abstracting thought of Nicholas Copernicus, who found the principal complicating point of the planets' visible motion in the motion of the Earth and succeeded in "abstracting" it by mentally placing an observer on the Sun. This was the first step of astronomical abstraction; later, it was easier to find and remove by analysis the other constituents of observed astronomical facts.

In the social sciences, their subject matter being enormously complex, real simplifying experiments are possible only in yet exceptional cases. Therefore, mental abstraction plays a decisive role here, too; its first patterns were presented in bourgeois classical economy and later, in a far more perfect and sophisticated form, in K. Marx's studies<sup>8</sup>.

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

G. Quincke's and especially O. Buetschli's experiments with "artificial cells" are well-known. They were obtained by preparing colloid mixtures which were close to living protoplasm in their physical constitution but not in their chemical structures; one succeeded in reproducing the principal motor reactions of unicellular organisms in these mixtures: the motion used by pseudopodia, like amoebae; capturing and enveloping solid particles;

copulation, etc. To which field of science should these experiments be referred? To biology? But its subject matter is living bodies and the phenomena of life which are lacking here. To the physics of colloid bodies? But the whole meaning and aim of these experiments lie outside its concern: the case in point is a new elucidation, a new interpretation of the processes of *life*. These experiments evidently fall within the scope of a science whose matter and objectives embrace both simultaneously: the science of the general structures of living and non-living things in nature, and of the organizational foundation of any form. We face the experiment in which exactly what we are accustomed to think of as "life" is "abstracted" from the vital function: all particularity is abstracted from the latter, and only its general structure and organizational basis remain.

J. Plato's old experiment reproduces a picture of the rings of Saturn by the use of a liquid sphere rotating in a medium which balances it, i.e. in another liquid of the same specific weight. Again, which field of science does this experiment fall within? Neither hydrodynamics nor cosmology can rightfully claim this experiment which relates to the issues of the basic architecture of the universe. It belongs essentially and entirely to organizational science.

The same can be said about R. Mayer's experiments explaining the possible equilibrium of the electrons in an atom by means of an electromagnet and tiny floating magnets or currents, as well as K. Bjerknes' hydrodynamic models reproducing the properties of the electrical poles and currents.

One can see from these illustrations the main feature of the application of the abstract method in tektology. The experiments of, for instance, O. Buetschli, or following the same way those of L. Rumbler, A. Herera, S. Leduc, O. Lemann and others, abstract *practically* the phenomenon of life from its "biological" material;

but next it is also necessary to abstract *mentally* from the material which has been used in the experiment. The real abstraction is indispensably complemented by the mental one.

Undoubtedly, even more often tektology will have to confine itself to mental abstractions.

Only the method of abstraction is capable of giving us genuine and universal *tektological laws*.

On their base a broad *tektological deduction* is feasible which will combine and apply them to yield new theoretical and practical conclusions. Of course, one may start having only simple empirical generalizations; but then, as the experiences of the other sciences show, it is hardly reliable. And when general laws are discovered, deduction provides a strong support for *systemic* organizational activities — practical and theoretical ones: then the elements of spontaneity, casuality, of anarchic inquiry, labour and cognitive efforts made probingly are eliminated. The full flourishing of tektology will express the conscious supremacy of people over external nature and social nature as well. For any practical or theoretical problem comes to a tektological issue, namely, one of the method of the most expedient organization of a totality of elements, whether real or mental.

To a considerable extent technological problems are now being solved in a similar manner, by the use of exact methods, although these problems are not yet formulated tektologically, i.e. as organizational. And the same is true for scientific techniques where the inertia of specialization, fractional and limited experience, the mutual isolation of particular methods undoubtedly prevents us from attaining the most general and the most perfect solutions; tektology is to play its role here, too. Whatever the social-economic, political, artistic, and most of the cognitive problems concerned, they are

entirely at the stage of the spontaneous elaboration of methods; incidentally, this is why personal "talent" and "genius", that is, organizational capability beyond the ordinary level, have such great significance in these fields. The role of tektology is doubtless bound there to be especially great.

Being applied in reality each tektological deduction gains an experimental test which at the same time is a verification of the laws which have served as the basis of the deduction. The success of tektological generalizations and conclusions first and foremost depends upon the correct analysis of the complexes being investigated, on their expedient decomposition into elements. It should have been implemented by the particular sciences; but in fact, this is far from having been always done by them because they do not hold yet to the tektological standpoint and continue to live their own detached, specialized lives. Often new experiments pursuing new aims will be necessary; they will consist, for instance, in the systematic de-organization of the objects under study, so that the objects' elements and their relationships can be discovered.

The methods of tektology, as is seen, combine the *abstract symbolism of mathematics* and the *experimental character of the natural sciences*. Furthermore, the very formulation of its problems, the very treatment of organizedness by tektology, as has been elucidated, should stick to the *social historical* viewpoint. And whatever the subject matter, or the content, of tektology, it embraces the whole world of experience. So tektology is really a *universal* science by its methods and its content.

Presently, tektology is just arising. Nevertheless, the path toward it was set by the other sciences and by living, organizational practice to such an extent that its results, even the first ones, may and must

find useful applications for themselves in the various fields of people's labour, cognition and intercourse.

### C. TEKTOLOGY'S RELATION TO THE PARTICULAR SCIENCES AND PHILOSOPHY

#### I

Organizational science is characterized first and foremost by its *point of view*. From this follow all the features of its problems, methods, and results. The difference from other sciences in their present state shows itself as soon as a *problem is raised*.

Two essential points should be ascertained.

Firstly, *any* scientific problem may be stated and solved from the organizational viewpoint, this the special sciences either do not do or do only unsystematically, half-consciously or as an exception.

Secondly, the organizational point of view forces the formulation of *new* scientific problems as well, which contemporary special sciences are not able to envisage or identify, or even more so solve.

The organizational point of view should, seemingly, be the closest to the life and social sciences as they study organisms and organizations. However, its presence there is far from being realized, and its implementations are not systematic or integral. Therefore, in many cases it will suffice to apply this viewpoint resolutely and clearly to a problem in order to gain immediately a new elucidation of all known facts, and then new conclusions sometimes differing drastically from the previous solutions.

For example, the whole immense problem of *ideologies*, i.e. the forms of speech, thought, law, morals, etc., embracing a vast area of the social sciences is usually treated without regard to the idea of a social organization as a whole, one whose parts are connected by an essential vital relationship. Marxism was the first to definitely ascertain this relationship, not completely, only partially, on one of its sides, namely, the dependence of ideologies upon the relations of production as the dependence of secondary, or derivative forms upon the basic one. It left unclarified the objective role of ideologies in society, their indispensable social function: within the organized system every part or aspect complements all other parts or aspects, and in this sense is needed for them as an organ of the whole with its special purpose. In some cases Marxism got close to this problem, revealing that an ideology serves the interests of a particular social class, consolidates the conditions of its domination, and is its arms in its struggle against the other classes. However Marxism did not state the problem generally and, in many important cases, adopted uncritically the old pre-scientific formulations. For instance, Marxism considered art to be a mere decoration of life, and the mathematical and natural sciences as pure and independent of social relations. The organizational point of view has changed at one stroke these conceptions, removed their mixed and indeterminate character, defined the true and necessary position of ideologies in the life of society. They are organizing forms, or, what is the same, the organizational means for all social practices. They are actually determined, in the course of their development, by the conditions and relations of production, though not only as a superstructure for the latter but precisely so, as the forms organizing some content are determined by this content, and adjust themselves to it. The whole ideological side of life is thought of in a new fashion and many of its enigmas are rather easily explained<sup>9</sup>.

A particular illustration of this kind of problem is the origin of animism, i.e. dividing men and other living beings, and originally all things in nature into "soul" and "body". The former theories of animism did not even touch on the fact that the relationship between "soul" and "body" is quite clearly of a social-organizational character, namely, it corresponds to the form of collaboration which I have called "authoritarian": the relationship between an actively-authoritative element and a passively-subordinate one, a leading element and an executive one. However, as soon as this aspect of the problem is taken into consideration, the new path toward its solution begins to show of itself. Animism turns out to be the organizational form of people's labour being which is transferred to thinking. In addition, there arises the possibility of explaining exhaustively all the peripetias of animism's historical fate: why had it not existed, as is presently recognized, at the initial stages of the life of mankind, before authoritarian collaboration developed? Why does it intensify in some ages of history and weaken in others, following the growth and decline of particular social forms, etc.<sup>10</sup>.

Many important issues of the political economy receive improper solutions or remain unsolved because of the specialists' inability to choose the organizational point of view. A striking example is those theories dealing with problems of exchange. The "ultimate utility" school, which dominates the old official science, proceeds from principles which may really be called "anti-organizational": it takes as its basis the subjective relation of the individual to his personal needs, the individual psyche with its fluctuating evaluation of useful things. Meanwhile, the exchange of goods is an expression of the organizational relationship between people in society treated as a system of production; and the individual psyche's activities with its subjective evaluations consisting in adapting this individual and his economy to the objective, independent conditions of social organization. Subjective evaluations can change for the individual

neither the prices of the goods which at the moment one finds at the market, nor moreover, the technological conditions of producing these goods, which are the most constant factors of price-setting.

Contrariwise, the labour theory of value proceeds from the idea of the social organization of production and in this sense keeps to the organizational standpoint. However, even this theory has not held so far quite completely; meanwhile complete and formal proof of its validity may be achieved only on further following this way. The proof involves defining the conditions of mutual exchange under which a capitalist enterprise is capable of maintaining and extending its share of work within the common system of production. It appears that it is capable precisely under the conditions of exchange based on labour expenditures with strictly specified deviations depending indirectly on this quota also<sup>11</sup>.

In fact, the most completely the organizational point of view has been so far implemented is precisely by those sciences which do not use the term "organization" — the physical and chemical ones. But its designation differs, namely, it is called there the "mechanical" point of view. This implies studying any system as viewed from the side of the system's internal relationships — between all of its parts, as well as the side of the relationships between the system as a whole and its environment, i.e. all external systems. As has been clarified, first one means by "mechanisms" organized systems systematically designed by people themselves, and then any systems whose structures one has succeeded in making as known and intelligible as those of technologically designed systems are known and intelligible.

However, the quite conscious and perfectly consistent implementation of the organizational idea in the physical and chemical sciences may yield new formulations of problems, too. For



example, discussions about the "principle of relativity" arouse great interest in modern physics. Its formulation and analysis are entirely based upon the relationships between observers accepting these or other events, and upon the conditions of signalling which let them co-ordinate their observations. The notion of the physical environment is evidently expanded here in the organizational sense; it is complemented by elements never before taken into account, namely, inquiring beings and their relationships<sup>12</sup>.

Generally, it should be evident for us that the organizational point of view can yield new, and promising new results, formulations of various problems of knowledge ever before raised.

## II

The organizational point of view gives rise also to issues which the separate special sciences have not been able to raise although these issues should be accepted as quite scientific. They are issues which relate to the unity of organizational methods in nature, any practices, and any inquiry.

There are, say, such scientific facts. The eyes of the cuttlefish or octopus are constituted very much similarly to those of higher vertebrates, e.g. men. Both are devices of enormous complexity with hundreds of millions of elements linked to one another in an orderly manner. However, one may think it indubitable that both evolved quite independently, on two distantly diverged branches of the genealogical tree of life; the common ancestors of men and octopi could not have had any eyes in the ordinary sense, at best — pigmentary specks in the body's outer layer to increase the absorption of light rays. This independence of origin seems to be

especially emphasized by the fact that in the higher molluscs' the layers of the light perceiving retina are situated in the inverse order compared to those of higher vertebrates. It is one of nature's most wonderful coincidences.

Can biology as a special science raise and study the problem of the causes of this coincidence and of its high degree? There is a general principle that similar functions lead to the development of analogous organs. Still the concept of "analogy" says nothing about the possibility of such a striking coincidence. For instance, man's corneous outer skin, the insects' chitin shell, the molluscs' lime shell, etc. are "analogous". Biology can trace two lines of historical evolution, retrace the series of transitions which laid two independent paths from a mere accumulation of pigment to the architecturally identical optical apparatus which are millions of times more complex than our microscopes and telescopes. However, the very isolation of each line precludes any chance of answering the question of the causes of the coincidence of their final results.

Biology in fact has never posed the question in this form though already more than sixty years have passed since A.I. Babukhin's research into the eyes of cephalopoda. But from the organizational point of view it *must* be raised. It is a particular case of the unity of nature's organizational methods. So it should gain a scientific solution on the basis of the analysis and generalization of organizational experience.

There is a "law of equilibrium" in the physical and chemical sciences formulated by A. L. Le Chatelier. According to this law systems being in equilibrium of a certain kind show a tendency to maintain it, internally they counteract those forces attempting to change it. For example, let a vessel contain water and ice in equilibrium at a temperature of zero degrees centigrade and at normal atmospheric

pressure. The vessel being warmed, causes part of the ice to melt absorbing heat and thus maintaining the constant temperature of the mixture. The external pressure is increased, again a part of the ice converts to water which occupies a lesser volume, thus weakening the increasing pressure. In contrast to water, when other liquids are frozen their volumes decrease but do not increase. With these mixtures, under the same conditions, the pressure increasing, they display an inverse change: a part of the liquid freezes. The pressure is evidently weakened by that as it is in the previous case. The Le Chatelier principle is applied at every step to solutions, chemical reactions and the motions of bodies making it possible to foresee systemic change in various cases.

Many observations evidence that the same principle is applicable to biological, psychological and social systems in equilibrium. For example, the human body's response to external cooling is the intensification of internal oxidation and other processes producing heat; its response to overheating is the increase of evaporation processes taking heat away. If a variety of sensations decreases because of external conditions, e.g. when a person is imprisoned, normal psychics, as if compensating for this shortage, strengthen the work of the imagination, and pay more attention to small details. On the contrary, if impressions are in excess, attention to particular detail becomes lower, the work of the imagination weakens, and so on.

It is clear that no special science can raise and study systematically the problem of the universality of Le Chatelier's principle: physical chemistry does not care for psychological systems, neither does biology care about non-organic systems nor psychology for material ones. But from the organizational point of view not only is posing this problem evidently quite possible but it is absolutely inevitable.

These problems are usually called "philosophical". This name covers two ideas. The first is precisely that these problems do not fall within the scope of special sciences. The second is that these problems are not strictly scientific, those studied by altogether scientific methods. The latter idea must be rejected.

As has been clarified, the problems of the special sciences may also be considered from the organizational viewpoint, i.e. "tektologically". This point of view is always broader and therefore can, at least in some cases or perhaps in all of them, give more complete and more exact results. The experiences of all the sciences show that the solutions of particular problems are not usually obtained until they have been preliminarily transformed to general forms, a lot of other problems of the same kind being settled together with the one initially considered. The main significance of tektology consists in formulating problems most generally.

Hence tektology's relation to the special sciences is easily established: *uniting and controlling*. All their materials and obtained results lawfully belong to it as the base of its studies; all their generalizations and conclusions are to be checked by it in order to make sure they are exact and complete.

For tektology the methods of all the sciences are but means of organizing the material provided by experience; and it studies them in these terms, as well as through various practical methods. Neither are its own methods an exception: for tektology any of them is just such another subject for study, an organizational device, no more. The so called "gnoseology", or philosophical theory of knowledge, which strives toward investigating the conditions and methods of cognition treated abstractly, as a process essentially different from practice rather than a vital and organizational process among a

number of others, is surely rejected by tektology which believes it to be unfruitful scholasticism.

Tektology should not be confused with philosophy. Philosophy was originally a mere collection of scientific knowledge related by naive generalizing hypotheses and not yet separated into specialities. In the age of the specialization of the sciences it is a superstructure over scientific knowledge expressing the aspiration of human thought for unity. However, as philosophy itself split into theoretical and practical branches following the principal gap of social life, so much the less was this aim actually achievable for it. Both branches radically differ from tektology.

Practical philosophy implies the general moral guidance of human behaviour. For tektology morality is but a matter of study as one organizational form among a number of others. It considers moral relationships between people from the same point of view as relationships between the cells of an organism, the parts of a machine or the electrons in an atom, etc. It is as foreign to morality as it is to mathematics.

Theoretical philosophy aimed *to discover* the unity of experience, namely, in the form of some universal *explanation*. It strived to yield a world *picture*, one which is harmoniously integral and completely understandable. Its tendency is contemplative. For tektology the unity of experience is not *discovered* but it is created in an active organizational way: "the philosophers have only interpreted the world in various ways; the point however is to change it", wrote K. Marx, the great forerunner of organizational science<sup>13</sup>. Explaining organizational forms by tektology aims at their *practical mastery* rather than contemplating their unity.

Philosophical ideas differ from those of science in that those of science are tested empirically; for instance, "philosophical

experiment" is quite an unnatural combination of notions. Meanwhile, tektology is sure to test constantly its conclusions by experiment: organizational laws are first of all required for applying them; and not only are tektological experiments possible but, as we have seen, they exist already. Here the radical difference is especially evident.

Working toward unity, philosophy time and again anticipated broad scientific generalizations. The most prominent example is the idea of the indestructibility of matter and energy. In this sense philosophy is the forerunner of tektology. Philosophical conceptions, such as dialectics or Spencer's teaching of evolution are of indubitable tektological character though it is implicit and unconscious. As they are studied, tested, and interpreted tektologically, they will be included in the new science, and at the same time will lose their philosophical character. Generally speaking, the development of tektology should make philosophy unnecessary; and from the very beginning the former is *above* philosophy, as combining the universality of the latter with a scientific and empirical character. Philosophical ideas and schemes are for tektology a subject for study, like any other organizational forms of experience.

Tektology is a general natural science. It is just emerging; but as it embraces the whole organizational experience of mankind, its development will become impetuously rapid and revolutionary, like tektology itself is by its own nature. Its full flourishing will manifest conscious human domination over external nature as well as social nature. For any practical or theoretical problem comes to a tektological question: how to organize most expediently a collection of elements, whether practical or mental.

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<sup>1</sup>The terms "organizedness" and "de-organizedness" are used in preference to "organization" or "de-organization" to denote Bogdanov's use of the terms "организованность" and "деорганизованность" which he intended as the *qualities* of an organized or non-organized complex rather than its structural characteristics or the act of organizing — Eds..

<sup>2</sup>In the original "целесообразность" — "expediency". In Russian this word consists of two parts, the first one "цель" means purpose, the second "сообразность" — "conformity" — Eds..

<sup>3</sup>A dessiatine is an ancient Russian measure of land. 1 dessiatine approximately equals to 1.09 hectare or 2.7 acres — Eds..

<sup>4</sup>1 pood = 16.38 kg — Eds..

<sup>5</sup>An interesting and important practical paradox is rooted in the changeability of resistances. If *A* is running away, and *B* is pursuing him, and they have absolutely identical capabilities and energies, then *B* will inevitably catch *A*: *A* has to quite independently choose his path, change direction, react to every obstacle, while *B* can, to a degree, 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.

<sup>6</sup>The term "activeness" has a special meaning in the Tektology in the same way as "organizedness". It is used here as being equivalent to Bogdanov's use of the Russian word "активность" a quality of the active complex in differentiation to "деятельность" which is translated as "activity". Sometimes, when the meaning is clear, the plural form of the word "активность" is used — Eds..

<sup>7</sup>Positive and negative quantities are symbols of motions *quite opposite* in direction; vectors are symbols of motions *various* in direction, e.g. like sides of a triangle. Moving along one side and then along another side of a triangle one reaches the same point that one would reach moving along the third side; this is represented by vector addition in such a way that the sum of two sides of a triangle equals the third side, though numerically the third side is, of course, less than the sum of two others. Vector theory, as well as quaternion theory and tensor analysis having evolved from it provide great simplifications for exploring problems of space, forces, velocities, etc.

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<sup>8</sup>One can find simpler and partly more detailed explanations of the three phases of inductive method in the following books: А.А. Богданов, И.И. Степанов, "Коллективистический строй" // Курс политической экономии (А.А. Богданов, И.И. Степанов., "Course of Political Economy"). Vol.I. 2nd ed. Petrograd — Moscow, 1918, pp.5-11, and А.А. Богданов, "Наука об общественном сознании" (А.А. Богданов, "The Science of Social Consciousness"), 3rd ed. Moscow, 1923, pp.13-26.

<sup>9</sup>A systematic review of ideologies and their development from this viewpoint is presented in my work "Наука об общественном сознании" ("The Science of Social Consciousness"). The review of development of materialistic and positive philosophical doctrines — in my book "Философия живого опыта" ("The Philosophy of Living Experience") (St. Petersburg: 1st edition, Moscow, Semenov, 1913). About class art and class science — in my books: "Искусство в рабочий класс" ("Art and The Working Class") and "Социализм науки" ("Socialism of Science"), (both 1918).

<sup>10</sup>This theory of animism was first outlined by me in the 2nd edition of the "Short Course of Economic Science" ("Краткий курс политической экономии") (1899) and later developed in a number of other works, especially in "The Science of Social Consciousness" ("Наука об общественном сознании"). So far there have not been any objections brought forward against it which are worth dwelling upon.

<sup>11</sup>An outline of this proof was first published in my article "Exchange and Technology" ("Обмен и техника") in the collected papers "Essays on a Realistic Worldview" ("Очерки реалистического мировоззрения"), (1st edition 1904, pp. 279 - 343). A more detailed and exact version is developed in the first chapters of the book by А.А. Богданов, И.И. Степанов, "Course of Political Economy" ("Курс политической экономии").

<sup>12</sup>I would note that the formulations of the "principle of relativity" elaborated by Einstein and others don't seem to me to be the final ones from the organizational viewpoint. They always consider only *two* observers and the light signalling between them. For example, the relative velocities of bodies are assumed to be always less than that of light, because direct light signalling would be impossible if the observers were moving away from each other faster than light, since in this case the light signal



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sent by one observer could not reach the other. Thus the velocity of light is velocity's *absolute* limit. Meanwhile, as soon as a third observer is introduced into the system of co-ordination as a mediator between the other two, the situation turns out to be different. When radioactive nuclei are broken up some beta-particles, i.e. electrons, fly out at a speed close to that of light, e.g. 285 thousand km per second (light travels at a speed of 300 thousands km per second). It should be quite clear for the observer placed in the middle, between these two particles moving in opposite directions that they are *objectively* moving away from each other at a speed of 570 thousands km per second, that is, faster than light. If one imagines that there are special observers associated with each particle, then they can establish this fact thanks to the observer placed between them, though direct observations would give them different results.

Application of the organizational point of view leads to a far more simple conception of the relativity principle than the usual one, to a conception which eliminates its enigmas. I set forth this conception in two special articles, one in the Collected papers "The Principle of Relativity and its Philosophical Interpretation" ("Принцип относительности и его философское истолкование") ("Mir" Publishing House, Moscow, 1923, pp.101-123), the other — "An Objective Conception of the Relativity Principle" ("Объективное понимание принципа относительности") in "Вестник Коммунистической Академии" ("The Journal of the Communist Academy"), 1924, N. 8, pp.332-347 (see also Addendum 5 book 2 — Eds.).

<sup>13</sup>From the eleventh of Marx's "Theses on Feuerbach" (1845), cited from: "Handbook of Marxism". Ed. by E. Burns, 1935, p.231 — Eds..

# Chapter III

## Basic Organizational Mechanisms

### A. FORMATIVE MECHANISM

#### § 1. Conjugation

Men, in their organizing activities are but pupils and imitators of the great universal organizer — nature. Therefore, human methods can not transcend those of nature, and represent in relation to them special cases only. But these special cases are, of course, closer and more familiar to us, therefore the study of organizational methods must begin with them, proceeding to the more general and then to the universal means of organization in nature.

It was long ago noticed and ascertained that men in all their activities, practice and cognition, merely join and separate the elements available to them. The labour process reduces to the joining together of various "materials", "working "instruments" and "labour force", and the separation of the different parts of the

complexes that result, in the production of an organized whole, a "product".

The effort of the worker, the cutting instrument and the piece of wood are joined, shavings and bits of wood are cut off, and the instrument having completed its movement is separated from the wood; a new effort is applied to the instrument bringing it into a new contact with the wood, etc. This is the chain of conjunctions and disjunctions which are sometimes comparatively simple, more often very complex and hard to describe in words, but there is always only this, and never anything else which these notions would not imply. Thinking is another such case. A generalizing effort links and joins together the elements or complexes of experience, the discerning effort separates them. Nothing beyond these limits can be there. Neither logic nor methodology has found anything else.

However, further investigation reveals that these two acts, joining and separation, play unequal roles, or occupy unequal positions, in human activities: one of them is primary, the other is a derivative; one may be direct, the other is always carried out only as a result. Suppose a worker must cut a piece of wood into two parts or, at least, break it; in general, he must divide it somehow. There is no direct, immediate act which can achieve this. The worker must bring the thing being separated into contact with either an instrument or his body's organs — the act of joining, and to apply a certain effort to this system — another act of joining. Breaking the thing's internal connexions occurs only as a *consequence* of these combinations, as a *secondary* event.

The situation is no different in thinking. Neither "discrimination", "opposition" or "differentiation" are possible without some preceding *juxtaposition*, that is the joining together of the complexes

being separated within a common field — the field of "consciousness" or "experience". It takes a long time for a child to be able to distinguish a cat from a dog or between two men from outside the family. Not until the child happens to see them both side by side, and their images become so habitual and firmly fixed in his consciousness can the child compare a clear image of the one who is absent with a perception of the one present, only then can the child "distinguish" between them, i.e. separate them in its experience. The very effort aimed at this purpose arises only if two complexes have something in common, if some of their elements blend and fuse when they meet in the field of experience. Consequently, here, too, separation is secondary, derivative; here too, it is gained on the basis of connexion.

Going on to the processes of spontaneous nature, study finds the same two points here; with the same correlation between them. Any event, any change of complexes and their forms may be represented as a chain of acts of which connect those which are separated, and separate those which are connected. For example, the nourishing of an organism is the joining of the elements of its environment to its composition; reproduction goes on through the separation of a certain group of elements from the organism; all chemical reactions reduce to the combination of the atomic complexes of substances and their decomposition; even the simple "displacement" of bodies can be treated as their detachment from those complexes of the environment to which they have been spatially bound, and the formation of similar connexions with other complexes. And for any breach of connexion, we can establish as an indispensable preceding point, an act of connexion. For instance, a free cell usually propagates through division based on its growth, i.e. the joining of substances from outside; the decomposition of a chemical complex occurs as a result of either its contact with other substances or the

entry of new activities, such as thermal or electrical ones, into it from without, etc. A completely independent act of separation which is not induced somehow by an act of joining can not exist.

Consequently, the primary point begetting the change, emergence, destruction, and development of organizational forms, or *the basis of formative tektological mechanism*, is the joining of complexes. I shall denote it with the term *conjugation* borrowed from biology, as more profound in its meaning and international in its use<sup>1</sup>.

One should have a clear idea of the *universality* of this concept to be able to treat it tektologically. Conjugation comprises co-operation, as well as any other social intercourse, e.g. conversation, the integration of notions into ideas, the meeting of images or aspirations in the realm of consciousness, the fusion of metals, an electrical discharge between two bodies, the exchange of goods between enterprises, and the exchange of radiant energy between celestial bodies. Conjugation connects my mind with the most distant stars which I see through a telescope, as well as with the smallest bacteria which I look at through a microscope. Conjugation includes the assimilation of the nourishment sustaining an organism, and the poison destroying it, the lovers' tender embraces, and the enemies' mortal combat, the congress of a trade union, and the combat between hostile detachments...

Organizational scientific concepts are as strictly formal as the mathematical ones which properly appertain to the former; "conjugation" is as formal a concept as the addition of quantities, the latter being its particular case. We consider two opposing armies as two conjugating complexes by the same right and on the same grounds as we would determine the total number of participants in a battle by adding the numbers on both sides. The subjective goals of

the involved sides do not matter in this case but their objective correlation is of importance. Both complexes are in the process of "interaction", their elements-activities merge, "influence" each other, in general, "combine", pass from one complex to another in the form, for example, of the seizing captives and equipment, as well as in the form of the reciprocal borrowing of experience, learning from each other, at least, the methods of fighting, and often other practical information, too. Throughout history the uniting of communes, tribes, and peoples into extensive societies was achieved both on the path of war and in the way of peaceful relations, friendly exchange. The difference consists in the amount of expended energy, the degree of attendant de-organization. The latter, however, will be seen to accompany any conjugational process, whether it inheres in a "peaceful" or "antagonistic" tendency. And the actual results are far from being predetermined by this tendency, often they do not correspond to it at all. For instance, the knife and energy of a surgeon conjugating with the vital complex of his patient may sometimes de-organize it to a greater extent than the knife and energy of a felonious murderer; a friendly message may inflict a mortal blow upon a person, and, on the contrary, malicious violence has many times caused the most positive changes in life.

Thus the results of conjugation may differ tektologically. Viewing this point generally in regard to the elements-activities which constitute a complexes' *contents*, one can easily distinguish three conceivable cases.

1. The activities of one complex and those of another join in such a way that they do not become "resistances" to each other; consequently they join without any "losses". This is the ultimate positive result. The most typical examples are: the merging of two

waves of equal wavelength with an absolute coincidence of their crests and troughs; the fusion of two drops of water into one, viewed from the point of view of the chemical activities embodied in their molecules; the simultaneous and similarly directed efforts of two workers applied in such a manner that they do not at all hinder one another, for instance when lifting a log by its two ends.

The more perfect the methods of scientific analysis become, the more decisively it is clarified that this case, in its pure and complete form, is but theoretical. In reality, the absolutely harmonious joining of activities does not happen in conjugation; it never happens such that no part of the two conjugating complexes is a resistance to the other. Two waves do not coincide with absolute accuracy, and the direction of the efforts of two workers are never completely identical. These "losses" may be practically negligible and, so being, are quite lawfully ignored, or even inaccessible to contemporary research methods but for rigorous scientific thinking they always exist. "Matter" is the most stable form of activeness known to us; but even the merging of two drops of water cannot escape the destruction of at least a few atoms or, at any rate, the distortion of their structure, this is also accompanied by the "loss" of a part of their electrochemical energy through its dissipation in vibrations. However, this provides no hindrance to the conception of this proximity to the limit as being quite equivalent to its achievement in a great many of the problems of practice and theory.

2. The opposite case occurs if the activities of a given complex turn out to be complete resistances to the activities of another and completely paralyze, or are paralyzed by, them. Typical illustrations are the merging of waves of the same length and direction but of phases which differ by half a wavelength; the oppositely directed

efforts of two workers; or the connexion of the charges of a Leyden jar's inner and outer plates, and so forth.

It seems at first sight that this case must be as ideal and "only thinkable" as the previous one. But this is not so. Doubtless, the directions of two complexes' activities are never quite opposite, thus their *equal* quantities can not completely paralyze or "neutralize" one another; there always remain active residues, though perhaps negligibly small. For example, when two persons pull each other in opposite directions with equal effort, some lateral and oscillating shifts always arise due to these efforts not being exactly in line; and even the mutual discharge of the plates of a Leyden jar never leads, of itself, to their absolutely neutral state; as this process is a series of "damping oscillations", which can never end by itself. However, the active residue of activities of one direction is, in its turn, completely neutralized if it encounters *an excess* of activities of an approximately opposite direction. In this sense full neutralization is quite possible and it is an extremely frequent phenomenon. The efforts of a worker can be fully paralyzed by the superior efforts of another, a positive electrical charge — by a greater negative one, and so on.

3. The most common case is the joining of two complexes in such a manner that their elements-activities are only partially added together, and, partially, are mutual resistances, that is, they are organizationally subtracted. For instance, two workers enter into cooperation, combining their efforts more or less successfully, they assist and, at the same time, unintentionally hinder each other; two waves superpose and partly amplify each other, etc. This or that correlation prevails, and it is this that the general properties of the combination depend upon.



This case by itself needs no special explanation. However, one should keep in mind that "the complex" is a conventional unit, and that the subdivision of it into parts which are treated as separate complexes depends entirely on the researcher. Particularly, they can be mentally isolated in such a way that some of them will have their activities completely, not partially, neutralized. For example, one can discover in a series of muscular efforts of two workers that some efforts of one are entirely neutralized by the unfavourably directed movements of the other. Consequently, having sufficiently analyzed the third case, we can see that it includes cases of the second kind as its specific moments as well.

Let us agree to call the result of the joining of the specific activities or corresponding resistances in the process of any conjugation its *analytical sum*. In the ultimate, but purely mental case, this sum is precisely equal to the arithmetical sum, in all other cases it is less. Certainly, due to the structural change caused by conjugation, there may later occur an increase of its specific activeness over the arithmetical sum. However, this should be considered as a result of the development based on conjugation, and not as the immediate product of conjugation treated as a partial or complete merging of the complexes entering it. The sum produced by the very act of this merging is equal to the arithmetical sum only if identical specific activities of both complexes are equal in the directions of their elements; if it is not the case they turn out to be, partially or completely, resistances to one another, and the resultant sum decreases. This does not prevent, as we have seen earlier, the *practical sum* of actions being, contrariwise, greater than the result of an arithmetical addition of the previous actions. This happens when the resistances add up with even more losses than the given activities; or do not add up at all.

In various forms and under various names the analytical sum of activities, as well as resistances, appears in all the special sciences — engineering, natural, and social. A farmer knows that sowing twice the number of seeds in the same field does not double productivity because the seeds' productive activities will compete, to a degree they will become resistances to one another. An operator knows that connecting two similar locomotives to a train does not double the motive effect, and so on. The sums which were recognized earlier as purely arithmetical, after more thorough investigation turn out to be analytical. For example, according to Newton's mechanics two velocities impelling a material point in the same direction add up arithmetically; now, according to the new theory of inertia it appears that the result is less than the simple sum, but the degree of reduction is elusively small for us in the case of velocities customary to our experience.

We can understand completely any practical organizational sum only when we have decomposed it into a series of the analytical sums of activities on one side, and resistances on the other.

## **§ 2. Chain connexion**

Now we shall discuss the results of conjugation, in general, in relation to the forms of the systems obtained.

The process of conjugation is obviously accompanied by a transformation of the complexes which have entered into it. This transformation may come, as is clear from the preceding section, to the "elimination" or, more exactly, to the neutralization of one complex or more of them, if several complexes are conjugating. But, apart from this, the transformation may be so profound that

observation will not "recognize" the former complexes, will not identify them as the same ones: the conjugation of oxygen and hydrogen giving water, the conjugation of two mechanical impulses yielding motion along the resultant vector, etc. However, the most common case is that when we accept, even after the transformation, that the complexes are "conserved", continue to exist, that merely their forms are altered. The extreme cases, those of elimination or radical reorganization, are reduced to this by thorough investigation. By tracing the elements of the former complexes within new combinations scientific thinking reconstructs for itself those former complexes, it finds under their altered forms their "indestructible" matter and energy, the activities-resistances of which they were constituted. For example, if the positive and negative electricity of a Leyden jar's plates has been mutually neutralized by conjugation — discharge, this does not mean that both activities have ceased to exist in cognition. Science explains the absence of their practical manifestations by the fact that the elements of both former complexes have grouped in pairs and, thus, have neutralized each other. But they may be separated again and brought back to the initial combination by applying the appropriate external influence, that is, by means of a new conjugation with a third complex. Similarly, although oxygen and hydrogen after combining into water are "unrecognizable", chemistry persists in finding them theoretically in its molecules, as their elements-atoms, and supplies methods of separating them again and grouping them into the former systems. Hence, from the scientific point of view the result of conjugation is, generally, a system of transformed, conjugated complexes.

These complexes may either remain mutually connected or dissociate again in the very process of change caused by conjugation. The biological "conjugation" of living, autonomous cells, connected

with their propagation, is of the second type: both cells, having exchanged a part of their elements, go their separate ways again and continue to divide independently. The collision of two elastic bodies, after which they continue to move, though in new directions and with new velocities, is also of this type. The process of separation may embrace parts of the initial complexes, too, for instance, when two glass bodies, having collided, smash into smithereens. Besides, sometimes the process of separation moves so far away from the initial separation into complexes that one can not identify which of the obtained complexes corresponds to a particular initial complex. An example of this kind is the exchange which takes place during chemical reactions, such as the reaction of soda (sodium carbonate) and sulphuric acid producing sodium sulphate, carbonic acid, and water. However, it is easier to begin this consideration with the simplest and most common case, where conjugating complexes are not radically re-organized and remain mutually connected: the joining of animals of different sexes into a family, people into a union, the images of consciousness into an association, and so on.

First of all, I would like to draw attention to the composition of the conjugating complexes themselves. We can consider organized complexes of quite different types and structures; but if we are searching for the elements they are composed of, we can easily ascertain for many cases, perhaps the vast majority, one common feature: the separate parts of such a complex are uniform or, at least, similar to a degree. For example, society consists of many uniform biological units — organisms; an organism, too, consists of uniform units — cells; the cell's composition includes a series of protein combinations which are very similar in their chemical properties. Alloys are usually formed of two, or several, substances which have in common the fact of their being metals. Cosmic systems consist of astronomic bodies, which in spite of their

diversity display many similar features; crystals consist of mutually similar and symmetrically oriented particles, and so on. This time we shall not discuss the question of whether this generalization is universal, or only a particular, though a very broad one. For the present let us put another question: how can these complexes appear in practice?

Let us assume that there are two uniform elements which are to be connected into an organized combination: two men, two things, two notions, two magnitudes, etc. Defining them as uniform we obviously admit they have something in common. But, as we don't take them for one and the same thing, we find a difference between them. Hence, it is clear that we treat them as complexes rather than simple, undecomposable elements. Being more or less complex they consist of partly common, partly different elements of the second order. The latter are the elements of which analysis should seek the conditions of an organizational relationship.

Suppose, two men join in collaboration. In this case, what connects them? It is the *common purpose* which enters into conscious of one and the other. This mental element, common to both of them, carries out an organizational function. Let us define its significance more exactly.

When speaking of their "common" purpose, do we mean that their purposes are similar or the same, and no more? One can easily see that we do not, "similar" or, at least, "identical" purposes are not sufficient for their organized joining. Two men may have quite "identical" purposes and, precisely for this reason, fight against each other, i.e., constitute a de-organized combination. For example, one can rightfully say, regarding two competitors, that their purposes are "identical": that which one of them wishes for himself, the other

wishes for himself also. But they are not, of course, an organization because they have no *common purpose*. The word "common" means coincidence rather than identity. In the case of competence, identical purposes do not coincide but diverge: their orientations differ. Organizedness is achieved only if the *direction of activeness* which is expressed by the purpose is the same for both collaborators. Therefore, the connexion is created by the actually common element, the one that is the same for both complexes<sup>2</sup>.

This scheme can also be used to explain, for example, the facts of magnetism. Magnetic elements in a piece of unmagnetized steel may be quite identical in all their properties but, altogether, constitute a de-organized whole because they are diversely oriented. If and when their orientations are in line, under the influence, for instance, of galvanic current, then, and therefore, they make an organized system — a magnet.

The limitation "if - then" expresses the imperfection of coincidence and, at the same time, of the organizing function. Usually two collaborators do not conceive their purposes quite identically and, accordingly, their efforts are not perfectly co-ordinated. Likewise, the orientations of magnetic elements are in line only partly even in the very best magnets.

Consonance is an organized combination of sounds and dissonance is de-organized in relation to the human perceptive ability. Two or more notes make a consonance, as is known, if some of their nearest overtones are the same. It is these overtones which are the organizing element of the accord. To our hearing these overtones make the common, main, tone in the true sense of the word. For even if a very sensitive ear discriminates this or that overtone, it can not analyze which part of its intensity corresponds to each of the

main tones: the overtone is perceived as a single sound rather than two or more, as one and the same common tone of the consonance.

The coincident elements on which this type of connexion is based may be diverse. It can easily be seen in the case of so called "associations by similarity" — the most ordinary form of psychological grouping. The notion *A* induces in the field of consciousness the notion *B* which has some elements in common with the former: this is the formula of such associations. As to these common elements, with what are they concerned? There is no question that they vary in different cases, and, generally, they may be of absolutely any kind whatever existing in experience.

The expression "association by similarity" does not exactly correspond to the method by means of which notions are organized in this work. The matter is that a part of *A* is identical to some part of *B*, and that it is one and the same part for both, rather than *A* and *B* are "alike". The actual similarity of two phenomena by itself is not at all sure to induce their association in the human consciousness: this often goes unnoticed and has been ignored for a very long time. Many of the great discoveries in the history of thought happened when these similarities were discerned where observations had, earlier, failed to recognize them. Association occurs when complexes similar in some respects meet in the same field of consciousness; but it is this very case, where their identical elements can merge and blend with one another; and only due to this, that real associative connexions emerge. When, for instance, in examining a distant object we hesitate in deciding whether it is a man or a column, there the possibility of hesitation depends on an "association by similarity" of their outer forms: a small number of available optical elements are complemented first by some elements then by others to create a more complex visual image; but the available

elements remain invariable, consequently, they are common to both of the associated complexes.

To understand the nature of connexion under study, those of its forms which may be called polar or contrasting, are of importance. At first sight they seem to be of a quite different type to those outlined earlier. Such as, say, the intimacy often observed between persons whose capabilities and inclinations are so different that they complement each other: one lacks precisely that the other is especially developed in, and vice versa. The so called "associations by contrast", when, for instance, a bright day causes the recollection of the darkness of night, the winter's cold — summer heat, and so forth, are of this type, too. Another example of this kind is the connexion of the elements of a galvanic battery into a chain: connecting negative poles to positive is the most efficient grouping provided the resistance is high; the connexion of magnetic elements: north poles — to south, etc. And the simplest example is the connexion of a convex surface and its reciprocal concave, a commonplace in practical mechanics, especially where a machine's parts must be mutually mobile; the same method is widely used by nature itself in the articular anatomy.

However, one can easily see that it is not at all a special type of connexion, opposite to the one discussed, but the same one, one of its particular forms. I could even take an example mentioned above — the structure of a magnet. Though the poles which link within the chain connexion are opposite their "lines of force" are common. And it is precisely the latter which express the peculiar activeness which is being organized in the magnet. So it is in a chain of galvanic elements, the current itself is the common element there, it connects poles as a river links an Alpine glacier or a lake to the sea. A bolt and its appropriate nut, the articular head and the cavity of



the coxal articulation are connected because the two surfaces coincide and become, practically, one common surface. Contrast associations of white and black, warm and cold, soft and hard, pleasant and unpleasant are based upon the participation of *the same elements* of opposite poles of the nervous apparatus merely in different or opposite organic states in the perception of each such pair. The mutual attraction of two men, opposite in nature, is observed if they are able to really "complement" each other. But it is possible "to complement" only if there is an incompleteness, a deficiency which those "completing" enter like a convex surface joins its reciprocal concave. Suppose, a person lacks some specific activeness, and another has it in excess; for example, the first is "a theorist" and the second — "a practical person". The organizational relationship between them, in the form of collaboration, friendship, domination, etc. will be realized if both of them have this activeness *oriented basically in the same direction, aimed identically at common purposes*. Then where effort of the one stops, the other's effort continues. So greater resistances are overcome than when these efforts are not merged in a common orientation, and do not connect at those common points where one of them stops and the other starts. The notion of "contrast" implies that some elements are common; otherwise this notion is meaningless. This is understood by psychologists who consider "associations by contrast" as a particular case of "associations by similarity".

Any connexion between complexes by means of their common parts I shall denote, for simplicity, with the term "chain connexion". In the examples given above pairs of uniform complexes or their series, with common connecting parts, were examined. Experience shows, however, that the chain connexion can develop unrestrainedly in the most diverse directions, and that their connecting elements can be constantly changing. Such is, for

example, the fanciful sequence of the usual association of notions: the image of *A* entails in the field of consciousness the image of *B* due to their common part *X*; and *B* at once involves *C* because they both have a coinciding element *U*; *C* leads to *D* due to some other link *Z*, etc. A drop of water reminds one of the sea, the sea — of the sky, the sky — of its luminaries, astrology, then — of people's death and the death of the Universe, of the law of entropy which some people treat as the cause of that future death, of the mathematical formula of this law and so on, infinitely, each time with different bases of the notions' junction. Similarly the everyday relations of people in society develops: *A* and *B* are tied by common tastes, *B* and *C* — by common aims, *C* and *D* — by common misfortunes and so forth: the chain meanders, interlaces, entwines with another chain, makes a tangle, embracing millions of people, the vast majority of whom do not even know of each other's existence.

Let us agree to denote as a "linkage" the totality of two, or many, complexes' common, identical elements involved in a chain connexion. The degree of the connexion, which is described as its "depth" and "durability" obviously depends on the linkage's development.

For example, let two pieces of metal be soldered galvanically. It is clear that the greater the surface of this soldered joint and the closer it is, that is, the more number of identical elements, the greater the degree of the two complexes' connexion, provided other conditions remain equal.

This is true for any type and method of "linkage". Suppose, two men are independently pursuing the same goal, a complex and broad one, for instance, the realization of some political or cultural ideal. Organizational coherence of their efforts will be achieved, of

course, only when their goals merge in the consciousness of each of them, and each understands it as one and the same, i.e., when they make clear the unity of their problems and plans. The more perfect this unity is ascertained and the more elements that are brought to real identity, the more organizedness is created for their work in this direction, all other conditions being equal.

A hand together with the instrument it holds make an organized combination for manifesting some activeness. Therewith, the more tightly the hand holds the handle of the instrument, i.e., the more elements of both surfaces coincide, the firmer the connexion.

The more fully the similarity of two mental images is "recognized", i.e., the more elements of both images are brought to identity in the consciousness, the greater the extent they are associated "by similarity".

It is easy to see from the previous examples that the chain connexion may be of two kinds: *uniform, or symmetrical, and non-uniform, or asymmetrical*. In the first case the very complexes being connected are identical, and so are their relations to one another: a chain made of round rings; a rank of soldiers, the collaboration of workers jointly carrying out a job which is the same for everyone, and so on. In the second case the complexes are not identical, and their relations to one another are different. For instance, a bolt and a nut are quite different in their forms, and, as to their common surfaces, the bolt's is convex where that of the nut is concave. Similar cases are the combination of hand and instrument, that of a superior and a subordinate, association by contrast, the collaboration of different specialists, etc. In this sense full, absolute uniformity, in fact, never exists: two complexes, two relationships can not be exactly identical. However, their non-uniformity may be so small that it is of no

practical importance for the particular problem under consideration. It is clear that in the case of uniform connexions complexes as parts of an organized system carry out identical organizing functions, while in the case of non-uniform connexions these functions differ.

In the many combinations of organic and non-organic nature chain connexions are revealed only by exact investigation using advanced methods: the common parts may escape the ordinary methods of perception. In other cases one has to complement these parts theoretically for they can not be made directly accessible to our senses; such are, for instance, the lines of force of magnetic and electrical complexes', light in the ether, etc. Hence, chain connexion is seen to be a *form of our thinking about organized combinations*: we can conceive them only by accepting that their different parts have common subparts; and if we do not find these common subparts we must construct them theoretically.

### § 3. Ingression

All problems of practice, cognition, and artistic creative work amount to the task of organizing some or other of the available elements or complexes into more complex groups which correspond to certain purposes. The simplest type of solving such problems is precisely the establishing of real or mental, as dictated by the character of a problem at hand, chain connexions between the elements or complexes which are being joined together. In so doing there may be various cases.

Suppose, there are only two complexes — human persons, and that their efforts in relation to a particular resistance are to be organized together. One can see from the very formulation of the problem that

there is no common part yet, i.e., precisely that part which would connect their efforts according to the formulated problem: there may be other common parts but they are not organizing in the given sense, i.e. not in order to allow the surmounting of these resistances. A necessary part here is the recognition of the common purpose entering each person's mind, that their individual recognitions coincide to a sufficient degree. How this new element's entry is realized does not matter for us at the present stage of analysis, however; only that it provides the organizedness which is needed. The matter reduces to the *changing* of both the complexes being organized — the enriching of both minds with new associations.

A common and identically understood purpose may be already present at hand but with each person recognizing it independently. Then it remains only to bring to their recognition this mutual identity by attaching to it an idea of the very identity of purposes, the knowledge of its presence in the mind of the other, a striving for the co-ordination of their effort. So, this problem is also solved by introducing some new content to both complexes though to a lesser extent than in the previous case.

As to organizing things, or the technological process, the simplest method is the same. If two things lacking common elements are being joined together, their structures must be altered so that common elements appear. If elements which can merge and coincide are already present, both things should be brought into such a relation that these elements become common. For example, a stone axe was made of a sharp stone and a stick by way of preparing common surfaces: either a hole was bored in the stone so that the stick could be hammered into this hole, or the stone was driven into the stick. In either case there was achieved such a close coincidence of certain parts of their surfaces that the irregularities of one

adhered to corresponding irregularities in the other and thus caused enormous friction; linking, practically, the two things into one.

Suppose, technologically, it is required that we connect firmly two pieces of metal, or wood, or a rope. The linkage is created by entering the elements of one complex into the other. To attain such entry directly is scarcely ever easy, and sometimes impossible. It is achieved simply for two ropes, for instance, by entwining the fibres of one with those of the other or "tying up" their ends. This simplicity and ease depends on the large *relative mobility* of their parts. The case of pieces of metal is different: under ordinary conditions their elements are hardly movable relative to each other; and if the very forms of the pieces are not exclusively favourable to connecting them as, say, those of a bolt and a nut, it can not be done directly. But technology knows methods of altering their molecular mobility: pieces of metal may be either entirely smelted which enables us to merge them into a single piece, or partially fused at the appropriate edges which enables them to be soldered together directly. Or, finally, it may be that the pieces are not brought to fusion but that heating increases mobility to such a degree that it enables "welding" with the help of a strong mechanical influence. Pieces of wood, however, can not be joined together through such methods: exposed to heating they are destroyed irreversibly, much earlier than the appropriate mobility can be achieved.

In such situations the method of *ingression* is commonly used, that is, the method of "*introduced*" or "*intermediate*" complexes. This role may be played, for instance, by a glue which in a liquid form easily conjugates with the surface of wood and then solidifies without loosing the acquired coupling.

Cognitive methods of uniting various complexes are quite similar to these, as though they have been duplicated.

Where it is possible cognition finds and merges common elements of complexes under study *directly*, this is called "generalization". For example, if there are mental images of the water in a river, in a brook, in a vessel and in some other thing, etc., then the linkage between them all occurs as if by way of their being superimposed on each other, the unity being created spontaneously in the form of a number of coincident elements. This is the basic, primitive phase of cognition. But it is often required as well that we alter, partly, the constitutions and structures of these complexes, complement them hypothetically with some elements which are lacking, i.e., to do what almost all scientific theories are based upon. For instance, so far in our experience the stars and planets are merely visual images. To link them cognitively to earthly bodies familiar to us their optical elements must be joined, say, with the elements of solidity and weight which are not at all provided by our experience and without which heavenly and earthly bodies can not be "generalized". We often do not even notice alternations of this kind; they are so natural and necessary for us that we do them unconsciously.

Where direct generalization in the area of knowledge fails, the most available method, as is the case in practice, is to increase the plasticity of these complexes. The main tool for this is "analysis": by decomposing complexes into their elements, that is, breaking mentally the bonds between these elements, thought imparts to them a "relative mobility". For example, the images of a man, a fish and an insect are very difficult to join directly together in the field of consciousness; and if they are superimposed on each other the combination is vague and initially dissociating. However, when biology decomposed these complexes, and it is noteworthy that it

first did this practically, into their constituents — organs, tissues, cells, there appeared a complete opportunity for such juxtaposition, i.e. mental conjugation, in which their common elements joined together reliably and a stable scientific ingression was obtained. Finally, when solving even more complex conjugational problems, cognition uses the method of "introduced", or "intermediate" complexes. For instance, it introduces between a man and a monkey the notion of a common ancestor, between spatially remote but interdependent bodies — the ether with its various tensions and oscillations, etc.

Thus, generally speaking, the chain connexion of two complexes requires that we alter them so as to obtain those common elements which correspond to the problem attended by the given organizing process. But it is hardly possible that we will be able to vary all such complexes, and it must be especially emphasized that under far from all conditions is precisely that variation possible which would enable us to link them directly. Then the solution of the problem, as was noted, requires that we introduce "intermediate" complexes. Let us approach this point more closely.

Suppose, two persons need to join their efforts for the same business. Full co-ordination is achieved only when they both have in their minds one and the same plan of action. They need "to come to an agreement" — a tektological process implying speech as its tool. But they speak different languages and can not understand each other. Successful solution of the problem, within the limits of these two complexes, is impossible: the chain connexion can not be established *directly*. An appropriate third element must be inserted between these two persons, in this instance a translator.



What is the special attribute of this intermediate link? It is that it includes elements which correspond to the problem under study and which are common to each extreme link although they are different in each case: the system of signals common to one of them is one language, and that to the other is another language. Those which happen to be organizing complexes "enter", or "penetrate" between the organized ones when a chain connexion is being built. From this stems the name of the method itself — *ingression*, i.e. "entering", "penetrating".

By way of *ingression* one can link even those complexes which would destroy each other if joined directly. An example from social life is the conciliatory mediation between two hostile or fighting sides. The mediator is a third person or organization bound up with each side by some common interest, material or moral. When the Romans and the Sabines met for a battle, those kidnapped Sabine women for whom Roman men had become husbands, intervened successfully between them.

Technology presents an infinite variety of applications of this method. One can not hold in one's hands a knife blade; but a handle whose form corresponds to that of the surface of a constricted hand, and whose material either merges with that of the blade or envelops its continuation in a coincident surface, binds *ingressively* the hand and the blade into a single system. Two wheels linked by a driving belt are an organized system in regard to technological aims: there is again a coincidence of the surfaces of an intermediate link and two extreme ones, a coincidence with the smallest irregularities upon which friction depends. One more example is two telegraph apparatus and a conductor connected to each of them by its electrical state. A wireless telegraph shows that the ether can play the *ingressive* role. From the standpoint of the electromagnetic theory

of light any optical image on the retina is a particular kind of wireless telegram emanating from a thing, so the ether is generally a universal ingressive medium for the radiative transfer of energy.

Complex driving gears in the area of machine production represent an example of ingression with a number of intermediate links whose connexions vary from one link to another. A long chain of ingressions is needed to create a system in which a waterfall spins cotton or lights houses.

Men can create ingressions practically only in the field of their muscular collective-labour efforts, therefore, within a limited scope. However, this scope is permanently widening with the advance of labour. Besides, experience shows that by means of expediently chosen introduced links, a single one or several or many, it is possible to establish real connexions between any kind of complex, no matter how distant in the field of labour or mutually incompatible by the directions of their activities they may be. One can co-ordinate the efforts of workers at opposite sides of the globe — merely a sufficient number of telegraphic stations and wires must be introduced between them. Negotiations between severely antagonistic enemies are possible to arrange — merely the appropriate mediators must be found. Mutual understanding and exact concordance of actions between Eskimo and Papuan or between English worker and Russian peasant can be achieved — merely learned and skilled translators are required. Fire and water may be joined for cooking or the frail cells of the brain centres and a steel tool — for producing or destroying, etc.

In the scope of knowledge any information first of all tends to arrange the phenomena it embraces in a continues series where every subsequent link will have as much in common with the

preceding one as possible. Thus an ingressive connexion between the most various objects is created. Further, neither can an explanatory theory do without ingression, more often without several ingressions. Due to this common feature of classifications and explanatory theories some thinkers considered erroneously the latter as the particular case of the former.

Let us take the most ordinary example — the theory of planetary attraction. Phenomena may be arranged in such a series: 1) the planets' elliptical orbits; 2) comets' elliptical orbits; 3) parabolic comet trajectories; 4) the parabolic path of a thrown stone; 5) the rectilinear falling of a stone left without support. Here every subsequent link has so much in common with the preceding one that the idea of the unity of causes seems very natural: thus ingression provides a base for the theory. However, the series constructed is not yet the theory itself. Ingression is but a necessary element in creating such complex complexes as scientific theories, and it is really always present there.

Common mathematical problems are nothing but the finding of intermediate links for connecting given values. This link may be, e.g., the value  $X$  realizing the mathematical relationship of the equation. Equally, finding intermediate links between some extremes constitutes the principal content of the mathematical proof of a theorem, the constructions supporting it, etc. The same occurs in other sciences, too, in the practice of schematizing in the form of the "proof" of their conclusions. The axiom permanently used in the construction of geometry, "two values which are separately equal to some third value are equal", expresses the simplest mathematical instance of ingression. A more general axiom, "two magnitudes functionally related to a third are functionally related to each other", plays a great role in analysis. For tektology, however, this is also a

particular case of the scheme — "two complexes each of which having common elements with a third are ingressively connected by it to each other".

The scientific terms "to solve" and "to prove" have an objective meaning — to organize some collection of data. "To prove" a theorem means to establish the definite organizational relationship between the magnitudes specified in its formulation. Usually this is done by means of introducing between them expediently chosen intermediate combinations. For instance, the theorem "the sum of a triangle's angles equals twice a right angle" is proven in the following way. Two connecting links are introduced between the mathematical complexes, the sum of two right angles and the sum of a triangle's angles: 1) the sum of one of the triangle's angles and its adjacent angle; 2) the same sum in which the exterior adjacent angle is divided into two sectors by a line parallel to the opposite side. By way of this double ingression both magnitudes to which the theorem refers are organized into the cognitive grouping of equality.

Cognition operates with far more flexible complexes, and its scope, which is based on the same field of physical work, widens much more quickly and easily. Therefore, correspondingly faster and more easily does it develop its chain of ingressions. Cognition, which time and again establishes new relationships where they were lacking previously, transcending any preset limits in progressively less time in the course of its uniting work, long ago came to the idea of the continuous relationship of all existing things, to the idea of "world ingression".

I have just considered the method of "ingression" as a particular way of creating chain connexions. But when analyzing complexes we can also decompose them as is necessary or desirable. In any connexion

of two complexes we can distinguish "the linkage" as a *special, third part* between them. Then the entire combination appears as an ingression. Hence, ingression is the *general form* of chain connexion.

#### § 4. Disingression

As was seen, the scientific definition of de-organization boils down to its being opposite to organization: in the last case a whole is practically *greater* than the sum of its parts, in the first it is *less* than this sum.

However, when the term *de-organization* is used, or one of its numerous synonyms: "destruction", "decay", "disintegration", etc., one usually thinks of the breaking of connexions, the separation of a whole and the isolation of its parts, rather than the mutual elimination of oppositely directed actions. To what extent is this conception correct and exact?

A freely living cell has grown to its ultimate size and is separating into two new ones. Is this "de-organization"? No, it is "fission", one of the processes through which life is *organized* in nature. By way of such progressive divisions of cells does every complex organism develop. Consequently, the point is that it is not a mere breakage of connexions.

Here is a seemingly quite similar case : a drop of dew separates into two or more droplets. This "destruction" is much easier but is perceived as de-organization. Why? It is known from previous experience that when broken into parts a drop disappears more quickly, that is, the sum of its resistances to the environment

decreases; while as far as cells separating during fission are concerned experience points to something different. Probably the common notion of "de-organization" implies as well, at least implicitly, *a decrease of the practical sum of activities by the very mode of their combination*. And this decrease is conceivable only in that a part of them becomes a resistance to some other part. It is this relationship which corresponds to the scientific characteristic of de-organization given here.

According to molecular kinetic theory the instance of a separating drop may be treated as follows. Two groups of molecular activities are assumed to act in a liquid: "cohesion", i.e. the mutual attraction of the particles, and "thermal motion", i.e. their kinetic energy. Inside the liquid both groups of activities taken statistically are not for the most part antagonistic to one another: the motion moving a molecule away from its proximate particles *against the line of cohesion* will, at the same time, draw it closer to others along the lines of cohesion. The activities are adding up in the first case, and subtracting in the second; the net result is a "neutral" relation. However, this relation is quite different in a certain part of the drop — its surface layer. There, if a molecule is moving away from the water's particles situated deeper in the bulk, it acts wholly *against* the cohesion of the liquid. Hence, both types of activities are really antagonistic there, and, to a certain degree, practically eliminate each other. And the breakage of a drop means, precisely, an increase of the surface, that is, the area of this mutual elimination, de-organization.

This scheme, however, is not complete enough. Complexes should be considered not only in regard to their internal structure but also in their relation to the environment. For a drop of dew the environment is first and foremost the atmosphere including the

water vapour it contains. According to kinetic theory, vapour particles, as well as those of the other gases in the air are in permanent motion along irregular, variable paths, staggered due to the frequent collisions of molecules. Those particles of atmospheric vapour which interfere with the surface layer of the liquid from the outside act along the lines of cohesion, and this action being strong enough, will join the composition of the drop: the process of "precipitation". It is directly opposite to the process of evaporation which is demolishing the drop. Taken jointly these processes express *the struggle of organizational forms* which are embodied in the drop and its gaseous environment.

Thus the "boundary" between a drop and the atmosphere is the area of not only the de-organization of the drop but also its creation ("de-assimilation" and "assimilation"). If processes of the first kind prevail the separation of the drop into two and, consequently, the growth of the surface will hasten the disappearance of the drop; this is what the "de-organizational" character of the fact boils down to. But it may happen that processes of the second kind are more intense, namely, when the atmosphere is "oversaturated" with vapour; then the drop "grows" due to the environment, and the expansion of the surface intensifies with this growth. The disintegration of the drop then takes on the nature of "propagation", as the daughter drops may also achieve the same threshold sizes.

A living cell propagating through fission is in a similar position: it has grown at the expense of environment, and its daughter cells may continue to grow in the same environment. On the contrary, if a cell is surrounded by an unfavourable environment, one which is destroying it, a division into two would merely hasten its death and would be de-organization<sup>3</sup>.

In practice the phenomena of de-organization intertwine so closely with those of organization that both characteristics very often turn out to be equally applicable regarding whatever activities of the complexes under study are taken into account. For example, in regard to their "fighting strength" against external enemies, daughter cells are, of course, weaker than the one they originated from: an enemy which would not be able to defeat the mother can, one by one, capture and take them up. Hence the practical sum is here less than the original one, and the act of propagation viewed from this point contains de-organization just like some kind of a break in the connexions between the units of an army. Next, from the viewpoint of the activities of "chemical affinity" and "attraction" a cell's division is an approximately neutral act: their practical sum remains the same.

The principal type of organizational relationship is ingression. Correspondingly, it is convenient to denote the principal type of de-organization as "disingression", that is, negative ingression. Even more so when it is obtained in the same way; for instance when the interference of waves takes place and there is either a partial "conjugation" or, even, a complete one with destructive results.

Let us examine in what relation disingression is to the breakage of connexions.

A small but heavy ball is suspended by a silk thread the other end of which is fastened; this system is known as a "physical pendulum". The thread is tight: the weight of the ball together with its own negligible weight make up a definite sum of activities directed at the centre of the Earth. The ball, however, hangs and does not fall because there is another group of activities — "cohesion" which



counteract the tension and, exceeding it in magnitude, more than paralyze it, preventing the ball from falling.

Now we conjugate a new complex to this system: we suspend another weight. As a consequence the sum of the activities of tension increases. If it remains less than that of the cohesion in every part of the thread then the pendulum will continue to hang as before. But assume that another relationship has been gained: at one point or, more exactly, at one cross section of the thread, at that place where the thread is, for instance, the thinnest, the sum of the activities of tension turn out to be *exactly equal* to that of the activities of cohesion. What will happen here then?

At first sight it seems that nothing special should happen: both groups of activities are mutually paralyzed, so neither of them manifest themselves in real changes. However, this is not the case.

At the place where complex' own activities are completely neutralized any resistances to *external* activities vanish. And the latter are always present. There are no, and there can not be any complexes isolated in themselves: every complex is surrounded by an *environment* of differently organized complexes, different activities. They are tektologically "hostile" to it, that is, while developing in their own directions they may disturb its form, destroy it; this does not happen precisely because it offers resistance. And provided the resistance has vanished, has turned to zero at some point or area, external activities will enter there, and the connexions of the complex can be broken. In the present case these may be, for instance, molecular collisions with the particles of the surrounding air. With the air being in a calm state, these collisions have an infinitesimal effect on the thread if its cohesion is normal. However, when its cohesion is completely paralyzed even an infinitesimal

influence is enough to launch the process which was impossible earlier: the particles of the air penetrate between the particles of the thread, the latter are disjoined. The complex has disintegrated: a *tektological boundary* has gone through it.

As is seen, it passed where activities were completely neutralized, what I call "*complete disingression*"<sup>4</sup>.

If the tension has not yet increased so as to be equal to the force of cohesion but is still less, the required influence of the environment will be not infinitesimal but finite, of an appropriate magnitude: a sound oscillation, a breath of wind or some other mechanical impact. But here, too, it is expedient to decompose the external activities into two parts: one which destroys a residual resistance, and the other which acts when resistance is zero. For example, if a piece of wood is being cut with a knife the process evolves as follows: the pressure of the blade paralyzes the cohesion of wood's molecules with oppositely acting tensions. As soon as this is achieved, the blade gains the possibility of moving into the wood's tissues.

One may still come across the notion of "empty space" as the absence of any medium. However, this treatment is quite faulty contradicting the entire sense of contemporary science. In every point of this "emptiness", the interstellar ether, anything placed there experiences the influences of electrical and magnetic forces, as well as those of gravitation, i.e. the same ones which in other more complicated combinations characterize any "material" medium known to us. If the resistance of the medium is minimal it signifies that it is made up of the least organized complexes. Nevertheless, this resistance exists; though, e.g., for a moving body at ordinary velocities it is infinitesimal, as velocity increases this resistance

increases, too; and when the velocity is approaching that of light its magnitude grows infinitely so that it becomes practically insurmountable. Consequently, the medium is always present; and therefore complete disingression always causes the penetration of the medium's elements-activities along the lines of the eliminated resistances, that is, it causes the creation of a tektological boundary.

A front line in a battle is a vivid illustration of a tektological boundary, as well as its possible changes. It passes where the hostile efforts of two armies mutually balance each other, and so far as they are balanced. When the balance breaks, as occurs when one side is advancing, the front line vanishes: conjugational processes develop — combat, clashes, in which the elements of both sides mix in various combinations and interactions. Then the activities of fighting may come to a balance again at a new front line or the conjugation goes on to develop further, and is completed with the formation of a linkage, realized, e.g., in a peace treaty or relations of dominance and subordination, etc. Another illustration is the boundary between the "north" and "south" halves of a magnet. Likewise it is conditioned by a reciprocal neutralization of opposite activities, and may shift when their relationship changes, for instance, due to the approach of magnetic masses or electrical currents. One more example are the nodes of standing waves in a vibrating body: these are the points where opposite oscillating motions are mutually paralyzed. Everywhere organizational boundaries have the same base — complete disingressions. Thus, any break of connexion may be represented as *the penetration of the elements of the environment into a system along the lines of eliminated resistances, that is, complete disingressions.*

It may seem an unnecessary piece of subtlety to distinguish permanently here the two functions which constitute the act of a

connexion's break: on the one side, complete disingression through which a system's resistances along certain lines are eliminated, and on the other side, the subsequent influences along these lines. But this distinction is determined not only by a claim to the easing of analysis and generalization — it is grounded in practice. Both functions can be executed separately by activities of diverse kinds; and, for instance, technology puts this to its use in numerous cases.

To cut or to section an iron strip in ordinary conditions enormous mechanical force is needed which can not be at the disposal of a common blacksmith. But the cohesion of the iron's particles may also be suppressed by thermal energy which is easily produced with the help of coal in a forge. This disingression may be carried out as either nearly complete — the smelting of iron — or incomplete but so substantial that iron softened by heating can be divided into pieces by several blows of moderate strength.

An example borrowed from the other pole of being. To break, to destroy an established organization — labour, political or cultural — by direct violence, impacts of such energy may be needed as are not available to its enemies. However, if the means can be found to sow distrust, differences of interests among its members or between the parts of the organization, that is, to create disingressions between its internal activities, then to induce its disintegration will be a much easier task, sometimes immeasurably easier. And this may be done by other methods as well.

A break of connexions always comprises a moment of disingression as its first phase; why then should not it be always considered as a phenomenon of de-organization?

The "boundary" area of a complex, treated as the sum total of its contacts with the environment and not merely its spatial "boundary", is always increased by a break of connexions. For an organized complex the environment is the world of external or "antagonistic" activities, and, consequently, the "boundary" is characterized by a chain of disingressions with them.

Let there be a labour organization which is disintegrating into two, or several, smaller ones. This means the breaking of a series of ingressive connexions between the efforts of workers: at just those points where the labour activeness of one worker earlier joined with and was intensified by that of the others, it now must contend with the energy of external nature directed against it. There the area of the collisions of human actions with the counteractions of the elemental forces increases.

Assume however, that inside the organization there existed already contradictions and discords, smouldering conflicts or, in other words, internal disingressions, and that the disintegration occurred along that line. Then the matter comes down to replacing a series of internal disingressions with a series of external disingressions. Obviously, if the sum of the second disingressions is less considerable than was the sum of the first, the act of division even taken by itself, independently of the results that follow is not de-organizational. And later, viable and fully active organizations often emerge instead of collapsed and decaying ones, as would be the case with their fission<sup>5</sup>.

A marriage, a small organization of two persons, sometimes comes to such a state that both sides "poison life" for each other, that is, their energy is wasted in mutual counteraction. Then a divorce or, generally, a break ends the de-organization of two personal lives.

However, since in this case the original bond is an irreversible or non-uniform ingression there is another possibility, namely, that the result of the break will differ tectologically for both parts: "liberation", the elimination of the destructive disingressions for one of the spouses, and "complete ruin" for the other.

A relationship of this kind is more sharply illustrated in a medical procedure — amputation. The surgical knife breaks the connexion between the sick organ and the rest of the body; for the part being severed this is immediate death, for the organism — rescue from complete de-organization. For one side former, eliminated disingressions are replaced by lesser ones, for the other — by greater ones, this is natural because their structures are different.

In practical life, especially social life, such "asymmetrical" cases often give rise to important and difficult questions whose essence is as follows: should the break of a connexion, its general result, be regarded as an organizational or de-organizational act? Far from always can this question be solved as simply as in the instance of amputation. As to human persons related by emotional ties, if there are contradictions the matter may turn out to be far more complicated. The problem is sometimes merely unsolvable if it is considered entirely within the framework of the given complex: the "liberation" from marriage of one person together with "ruin of life" for the other, and so forth. It can be finitely solved only when the disintegrating group is treated as a part of a more complex and substantial system; for instance, a family as a part of society or a group of people as part of a certain estate or class.

Common reason usually formulates this question as "what is better?" (perseverance with, or the breakage of, connexion). The unrecognized tectological meaning of this formulation is: in which

of the two cases is the organizedness higher? Definiteness is attained through the questions "Better for whom, for what, etc.?", i.e., when that organizational unit is indicated which is taken into account therewith; be it one side or the other or a more comprehensive complex embracing both sides. And, depending on the choice of viewpoint, absolutely different solutions are possible. For instance, the divorce will free both sides of burdensome contradictions but as to society, if its organization is Philistine and conservative the divorce will undermine its foundations or principles, it will be the source of new and more extensive contradictions. Or, say, the split of a political organization is desired and immediately advantageous for both separating parts but for the class group, whose body it is, the split will disrupt the unity of its consciousness and action<sup>6</sup>.

Here is an example borrowed from another field — psychological association. Two groups of aspirations are "competing" in the human soul: suppose, to serve the God or mammon. Meeting in the same field of consciousness, that is, in the same associative complex, they form a series of disingressions, where parts of their psychic activities mutually paralyze each other. The solutions of a thus emerging organizational problem may be various depending on the whole sum of conditions. It may be that one among them is based on the break of the direct associative coupling between these two groups. Along the lines of the most full disingressions the elements of the psychic environment penetrate and uncouple these complexes, just as the elements of the physical environment disjoint the parts of a disintegrating material substance along the lines of disingressions. Two systems of aspirations become increasingly distant, and do not converge in the common field of consciousness: at some moments, hours, days the man serves God "not thinking" of mammon, and vice versa at others. No doubt, both groups directly gain from this solution: their organizedness increases. However, the connexivity of

these psyches as a whole may well decrease due to this bipolar organization.

Folk tektology with the symbolism of its proverbs, sayings, parables, etc. has been much concerned with issues of the breakage of connexions. By the way, the idea that the break is determined by the intrusion of some foreign elements between the sides of a connexion is also not alien to it. It is said, about a friendship or marriage beginning to break down, that "a black cat has run" between these persons. But in general, folk tektology seeks, of course, not explanations of facts but for practical patterns, instructions which could uniformly, mechanically so to speak, guide human actions and thoughts.

From the viewpoint of scientific tektology the problem formulated *in such a way* cannot be solved; there exist too many diverse combinations of organizational conditions and relationships. Therefore scientific tektology must seek out only those methods of studying combinations of the kind that allow the solving of a particular problem in every case under consideration, not ready-made universal solutions. Nevertheless, how did folk tektology manage its formulation of problems? It worked out patterns suited to most of the situations occurring in the life of society. And as it was formed mainly in times of conservative social organizations, i.e. those inimical to any changes to existing relations, its usual tendency is against the breakage of connexions, for example, "better a lean peace than a fat victory", "the more the merrier"; or, particularly about marriage, "patience is a plaster for all sores". The imperfection and inadequacy of formulae of that kind for more developed and complex social forms needs no special proof.



### §5. The Separateness of Complexes

The disruption of bonds, based on disingression, creates *separate* complexes where before that there was an integral whole, i.e. it produces a "separateness". The world is full of *separate* forms and, naturally, the question arises as to whether each of them has the same origin as that which we have just considered. This is one of the fundamental tektological problems. Philosophy has also approached it, in its wanderings, by looking for the "principle of individualization" of the existent world. But in its abstract, and disconnected from living experience, formulation, it inevitably turned into the subject matter of conjectures and metaphysical constructions. Tektology regards it as a problem of method, and thus it becomes infinitely far more simple and resolvable.

The notion of "separateness" has, first of all, a practical meaning, it implies the *interruption* of some of the activities (resistances) that we are confronted by. We consider a river bank as something "separate" from the river that washes over it, or a vessel — from the liquid it contains, because we feel the transition from one of these complexes to the other as the cessation of some sensed resistance, for instance tactile, expressed by the word "solid", and their substitution with others — "soft", "mobile", or the cessation of some activities of light — "opaque", "dark", and their substitution for others — "transparent", "brilliant"... The two banks of a river may represent identical activities-resistances, but for us they stay "separate", because the transition from one shore to the other is realized through the interruption of these activities-resistances, through a region where they are substituted by others. Similarly, two sides of a vessel are sensed as "separate" if we pass from one to the other through the water or gas it contains, and as "not separate", as "one and the same" side, if we pass through only by their surface, as when gliding over it with a finger or a glance.

Since our practical attitude — our effort or our interest — can be directed towards the different activities-resistances of complexes, it is natural that any specific application of the notion of separateness may also differ in correspondence to it also. For instance, if a thing consists of two pieces of different metals soldered by galvanization, then from the point of view of tactile, or, in the case of its scientific study, mechanical, activities, it is an integral body; but from the point of view of light (the different colours of the metals) or chemical phenomena they are two different complexes. Generally, when we speak about the separateness of some or other complex, we mean the particular activities, which pertain to this notion, and exclude those which do not pertain to it.

So, the problem of the separateness of complexes can be reduced to that of the conditions under which the *interruption* of the operation of some activities-resistances is practically manifested. Up to now, all the progress of the natural sciences has led towards the domination of the idea of *continuity*, toward its expansion into all kinds of phenomena, i.e. into all those processes and correlations we meet in our experience. While for the older schools the [basic] type of activities were represented by mechanical motion, and for the newer schools — by electrical energy, both types share the common feature of an unlimited continuity of action: the motion of a body, if it is unrestrained, is continued infinitely, remaining self-identical; an electrical field, even if only of a simple electron, spreads towards infinity; the way of all radiations in the ether is also infinite, etc. And this character of activities must be co-ordinated with the idea of separateness, i.e. of the interruption of their action. How can we resolve this problem? In all we have already discovered, only one way of doing this is obviously implied: interruption is produced by *disingression*. All other methods are unthinkable without us coming into conflict with the scientific principle of continuity.

Let complex *A* be in any sort of contact with complex *B*, but is considered as being separate from it, because it contains activities *A*, which are absent in complex *B* or which, being present there, are not manifested in the boundary area of both complexes, i.e. they are somehow interrupted during the transition from *A* to *B*. What is the reason that they do not penetrate from *A* into *B* directly and are not exchanged between them by means of conjugation? There would not be any reason for this if the activities of *A* did not meet certain obstacles to their expansion in the common boundary area. But this obstacle can be represented only by a resistance, which is *equal and opposite* to the actions of *A* in certain points, and which then forms the boundary area. And this resistance, which is equal and opposite to the activity, constitutes a *full disingression* with it. This is the meaning of any "separateness".

Certainly, the division of an integral whole into two separate complexes is a particular case of the scheme. It is applicable as well to all cases where separate complexes have not been connected before.

But is this scheme really applicable to *all* cases? Are there some to which it is unfitted, or is unnecessary for their understanding? Some of the illustrations given above provide grounds for doubt. If a vessel and the water it contains are separate things, then what disingression can be the cause of that? And is not it easier to get along without it, to adopt the common idea that these things are too different to mix and, therefore, are separate?

In spite of its first sight simplicity and convenience, this resolution is unsatisfactory, and there are two reasons for this. Firstly, it is purely verbal and does not explain anything; precisely, the most different things, in other cases, mix and lose their separateness, for instance, haloids make compounds with metals most rapidly and

intensively, etc.; and generally, to explain separateness by the properties of the things under consideration without providing these properties with a general and precise scientific formulation, is to reduce the solution to the formula: "things are separate because they have the property of being separated". Secondly, the idea that a vessel and the water which it contains are things which "cannot be mixed" is also false: in fact, they are always "mixed" to some degree, and this does not prevent their relative separateness.

Modern chemistry accepts the view that every contact between different bodies can produce *all kinds* of reactions between them. And the reason that only a few, or sometimes even none of them are observed, is that they proceed with different speeds — from the huge, as represented by "explosive" reactions, to the "infinitesimal", i.e. those that, practically, cannot be traced with existing methods. By changing the conditions, for instance the temperature, or by the introduction into the contact area of special substances (catalysts), we can alter the speed of these reactions to a significant extent, and frequently make the "infinitesimal" into the finite and, therefore, available to observation and measurement. All kinds of reaction must also take place between the glass of the vessel and the water it contains; under usual conditions they are absolutely imperceptible; but, for instance, by intensive and extended heating they can be analytically discovered: the water dissolves the glass by taking away its base of silicic acid, etc. Consequently, the conjugational chemical processes between the vessel's glass and the water really take place. There is an intermediate area where they proceed, one where the activities of the chemical kinship of the elements of the water and the glass operate, where there is no real separation between these complexes: this is the area of the chemical "bond".

But why do the processes of conjugation between the water and glass proceed so slowly that, under usual circumstances, their speed is

"infinitesimal", while if we were to take a vessel made, for instance, of common salt, its separateness from the water would quickly disappear and we would have a solution? We cannot explain it in that the amount of chemical activities in the system "glass-water" is insignificant, for, in general, it is no less here than in many other cases where we observe rapid and energetic reactions: the *stock* of chemical energy, which we can evaluate by other objective data and which is, of course, measurable, here belongs to the average of these values. Consequently, we should accept that the chemical activities are somehow paralyzed and neutralized; but this means that they meet resistances, which are equal (or practically equal) to them. Wherever we find this equality, there lies the border of the conjugational processes between the two complexes, i.e. the conditions of their separateness are present. And, whatever the specific representation of this correlation is — whether in the form of actual chemical reactions going on in parallel and simultaneously in opposite directions, or as reactions restrained at their very inception by counter-acting forces, as is most probable in our case — the whole thing can be reduced to disingressions, although different kinds of them.

In general, since we, on the one hand, understand reality as dynamic, i.e. we consider activities-resistances to be its elements, and, on the other hand, recognize the principle of continuity, we have no other way of explaining separateness, i.e. the interruption of actual sequences, but through disingression. It is quite similar to the way that we must necessarily understand the conservatism of things — by adopting the same dynamic evolutionary approach to them — in the form of the mobile equilibrium of two opposite currents of change; any other way of doing it would be inherently contradictory and de-organized from the very beginning.

Often, the case is of the separateness of complexes, which do not touch each other at all, being separated spatially, by other complexes. Of course, in this case it is also overtly or covertly accepted that the certain and specific activities of the given complexes, for instance, of the Earth and Sirius, do not exist in the intermediate area, that they are paralysed or neutralized in many of their points. Such are the usual mechanical and chemical activities of these bodies. For instance, the Earth's atmosphere does not spread to Sirius nor that of Sirius to the Earth, although the pressure of their gases strives to *expand them to infinity*; the border of expansion in both cases is laid by the disingression of the gases' pressure with their weight, under the influence of gravity; where these two values are equal, there is the boundary of an astronomic body, because beyond it there is no more of its *own* matter, which is considered for the determination of its borders.

This is real separateness. But there is, besides, another separateness, which is "just thought". For the purposes of cognition people often resort to fictitious separatenesses, dividing in their ideas or acts of thinking, things which they cannot, or do not know how to, divide in reality. For instance, the Earth is divided into Southern and Northern hemispheres: no real borders are present here, the equator and the first meridian are only imaginary, rather than drawn by nature or by people. Not infrequently, we mentally separate each kilometre of a journey from the next, and even when they are marked by sign posts it is clear that the posts are by no means borders, say, between the tenth and the eleventh kilometres, but only a symbol or token of their mental division. Nothing precludes us from the ideal separation of each of the 150 million kilometres between the Earth and the Sun. Even more distinctively may appear the separateness of complexes in time, for instance the delimitation of the phases of a light wave, the delimitation of the periods of the development of mankind or the mental delimitation of hours,

minutes, seconds, etc. But scientific and philosophical abstractions go even further: there we can find such "separate" subjects of thought as space, time, the contents of experience, form and content in general, etc. By what methods are all these separatenesses created and do they have anything in common with the real correlations which are referred to by the same word?

The equator divides the Earth's surface into two hemispheres. This mental operation is made manifest as follows. Every movement along the surface of the globe is viewed as *interrupted* at the moment it reaches the equator. But if the movement is interrupted for a single moment of thought, it means that its kinetic activity is neutralized for a moment by a sufficient resistance, i.e. the case is of a full disingression, again, of course, only in thought?. In the human psyche the ideal movement is represented by an incomplete effort, a weakened, unfinished, prolonged innervational process; and the interruption — by a paralyzing effort of the same kind. Psychophysiologicaly, this disingression is a real one, so the character of this "separateness" conforms to the general scheme.

The same ideas are applicable to any fictitious division in space, for instance, to the ideal division of some distance into kilometres, centimetres, microns, etc. Not unlike this is the case of complexes which manifest temporal separateness, such as wave phases, astronomic periods or periods of development.

Some temporal separatenesses may be called "natural", for instance, the swinging of a pendulum or an individual sound or light wave. The swinging of a pendulum stops at zero velocity, when its movement is completely eliminated by its weight and the resistance of the thread, consequently, at the moment of full disingression. Similar disingressions of activities serve as the boundaries of waves.

Mathematics expresses these limits precisely in that some derivative function of them becomes equal to zero.

But quite usual also, are the arbitrary, "artificial" divisions of time, for instance, the boundary between the old and the new year, certain dates of payment, terms of use of goods, etc. Here we also deal with an imaginary interruption of some process, i.e. we imagine an instantaneous paralyzing of some activities, which provokes changes. The moment of the meeting of the old and the new year is thought as the instantaneous arrest of life in the Universe at a certain boundary. And the arrest suggests that all these activities have been confronted by resistances which they must overcome in order to proceed with their natural roles.

The psycho-physiological mechanism which realizes this fictitious arrest of time is quite similar to the one which takes place in the case of fictitious divisions of space. Here at first there is passive attention — a prolonged reflex effort following the process of changes. Then it is deterred, paralyzed by the interference of active attention — a deliberate effort confronting it, a volitional arrest. And again the case is of a full disingression in the sphere of innervational processes.

Finally, a vast class of fictitious separatenesses is represented in analytical abstraction; for instance, the colour of a thing is mentally separated from its form, the space, occupied by a body — from its material substance, the categories of knowledge — from the experience they embrace, an "essence" — from its "manifestations", etc. We can also "think" the isolation of a group of elements of one type from elements of another type which are inseparably interlaced with them, for instance, visually-spatial from colour. In fact, psychologically there is a break here between two associations of representations, arranged and consolidated by two concepts. And



this break means a real disingression of the psychological activities in the boundary area of the two associations. The scheme of separateness remains the same.

So, *without exception any interruption of experience can be understood as a result of the disingression of continuities*. It is an episode in the process of the continuous flow of the Universe — the flow of activities-resistances.

The gifted scientist and reactionary philosopher Henri Bergson built the whole of his system on a misunderstanding of this relationship. By means of a skilful combination of unresolved, or not at that point fully clear to contemporary science, problems he tried to belittle its power and potential in order to restore metaphysics. His central point is the contrast between the "intellect", to which he ascribes the understanding of experience only in the forms of separateness and discontinuity, and "creative impulse" represented in consciousness by "intuition", which breaks all boundaries and proceeds in the form of a continuity. For him, this dualism is fundamental and unresolvable on the basis of intellect, which is limited. In fact, this problem is, for science, i.e. for the real, rather than that which is castrated by Bergson's interpretation, collective intellect, is fully resolvable. Intellect is commensurable with "intuition" and can study it.

The scheme of separateness confirms the continuous interdependence of practice and knowledge. The *method of explanation* of a certain type of fact or correlation here, as in other cases, comes down to *the method of the active reproduction* of this type. In technology and in social life people produce separatenesses by means of disingressions. This is where the explanation of "separateness" comes from. Correspondingly, people and society support and preserve themselves by a systematic replenishing of their energy

expenditures: this is the general scheme, which "explains" the conservatism of forms, the scheme of "dynamic equilibrium".

### §6. Crises

The break of the tektological boundary between two complexes is, in general, the start of their conjugation, the moment, when they cease to be what they were, that is, tektological separatenesses, and form some new system, with further transformations, the appearance of new links and partial or full disingressions; in a few words, this is an organizational *crisis* of these complexes. The formation of a tektological boundary, which creates separatenesses out of a given system, also makes the system organizationally different from what it was; this is also a *crisis*, although of another type. All crises observed in nature, all "reversals", "revolutions", "disasters" etc. are of one of these two types. For instance, social revolutions usually break the social barriers between different classes; the boiling of water breaks the physical borders between the liquid and the atmosphere, the reproduction of a living cell creates vital borders between its parts, which thus become independent; death is a break of the vital bonds of an organism, etc.

For the sake of brevity, we shall call crises of the first type "crises C", and those of the second — "crises D"<sup>8</sup>. From what has already been said it follows, that crises C are primary: any disjunction is made possible only by past conjugations. For example, the division of a mother-cell into two daughter-cells is the result of its growth, feeding, i.e. its conjugational inclusion of the elements of its environment; death is the result of the invasion into an organism of external activities: rapid and unusual in case of a forcible death or acute infection, and gradual and successive — in the case of death from old age or the disturbance of its metabolism, etc.

### §7. The Role of Differences in Experience

Perception takes place only when there is a difference of energy tensions between the perceiving apparatus and its environment. Objectively, something occurs only where there is a difference of energy tensions between adjoining complexes. So, the difference of tensions is an indispensable condition of all physical and psychological experience. This is the point of view of contemporary scientific thought which is implied by the very notion of energy. For contemporary science, energy is both the source of change and its quantitative measure: *the activeness, perceived sensually or adopted mentally as the source of change*. Whatever concerns us as this "tension" (temperature, potential, weight, etc.), this is *the relative amount of change made possible due to the given energy of the complex*; for instance, the higher the temperature of a body, the relatively greater is its heating action on surrounding bodies; the higher the water level in a basin, the relatively greater is its hydraulic action, etc. Clearly, where there is a confrontation of two activities, the relative amounts of the possible actions of which are equal, i.e. which can produce them with equal intensity, no action is possible; it can be produced only when these intensities differ between themselves.

It is easy to grasp the vitally practical origin of this scheme. The concept of energy comes from an idealized, and extended onto nature, notion of *work*; which has been refined from anthropomorphism, the concept of energy is in a relation of similarity to the notion of *effort*. When equal efforts confront each other no change is produced. The same is true for equal energy tensions.

But certainly, this is nothing other than the tektological scheme of "disingression". And the difference of tensions, which is indispensable for anything to occur is, therefore, an *incomplete disingression*.

Imagine that there are two adjoining complexes *A* and *B* of whatever nature. One of them can be, for instance, a living organism with perceiving sensual organs; the other one will then be one of the complexes of its environment. Let nothing occur between them. This means that they are divided by a real border, i.e. there is a surface between them, or an area of *full disingression*, a balance of energy tensions or a balance of confronting activities.

But let the balance of tensions be violated. It means that the full disingression, i.e. the real border between complexes *A* and *B*, does not exist anymore. Activities are transferred along a line from the greater to the lesser tensions, for instance, from complex *A* to complex *B*. Evidently, this creates conjugational processes between the activities which are transferred from complex *A* to complex *B*, as when we open spigot between two vessels, the liquid from that with the higher pressure streams into the other, blending with the liquid contained in it or, generally, entering into a certain interaction with it.

The outcomes of the conjugational processes may be different — both positive (new ingressions) and negative (new disingressions). Sometimes it happens that *A*-activities, which penetrate into complex *B*, meet resistances which counterbalance them; then a new area of full disingressions — a new real border between the two complexes — is established. For instance, an Army with great efforts breaks through the defensive line of its enemy, compels it to retreat, but at a certain distance, exhausted by the strain, and weakened by lengthened lines of communication, finds itself in a situation of a

relative balance of forces with its enemy and stops before a new defensive line. Heightened air pressure allows the air to penetrate further into a barometer tube; but the pressure of the mercury compressed into a longer section of the barometer rises and counterbalances the surplus atmospheric pressure, so that a new border line is established, etc. In other cases the process goes further, and the border between two complexes completely disappears, as happens when two bodies are chemically compounded, two cells biologically copulate, etc.<sup>9</sup>.

In correspondence with these new ingressions or disingressions, a structural change of the two interacting complexes occurs: it can be partial or fundamental, take the shape of deformations or crises, of development, degeneration, destruction.

Let us go back to the case where one of two adjoining complexes is a living organism, for instance, a human. Then the violation of the balance of tensions is called "irritation".

In a vast number of cases the resulting transfer of activities rapidly finds a new border at the very periphery of the organism, counterbalanced by its local resistances, so that the process does not spread towards the nervous centres; these irritations are "imperceptible", they do not produce "impressions" or enter into the sphere of direct experience. In other cases, the difference of tensions cannot be neutralized on the spot and the nerves transmit it to the central system. There, it produces a number of changes, energy transfers, which either affect only a limited number of cells of some "lower" centre, or are spread more broadly, and engulf the cortical area; in the first case, it is not a conscious but a "subconscious", hidden experience; in the second — it is "an act of consciousness". In both cases there is a possibility that the difference of tensions can be finally neutralized in the nervous centres; then no external

reaction by the organism to the received impression will be observed. But frequently the wave of differences of tensions is not exhausted inside the central apparatus, but spreads along centrifugal lines further, in a kind of innervation, towards the motor or secretion organs. Then we can observe an external reaction: a "reflex" or "instinctive" action if the lower centres are its starting point, or a "conscious" action if they are the higher ones. The process is completed when the results of the external reaction, or action, eliminate the conditions of the original irritation, for instance, when a hand, touching a hot thing, is drawn back.

Besides, the nervous centres may create "self-induced" irritations, which are not produced by direct action from the outside on sensual organs or transmitted by the centrifugal fibres; psychologically they are "representations", for instance, memories. Here, the central differences of tensions are the consequences partially of structural re-groupings, gradually developed from past external irritations, and partially — of the nervous cells' energy accumulation from inside the organism due to its feeding and assimilation. But even this assimilation is the result of a difference of tensions, that between the nervous cells and the internal medium of the organism, i.e. the blood or lymph.

So, the whole world of human experience, taken both as a system of consciousness and system of action, in each link of its infinitely unfolding chain, is the result of some or other difference of tension, some incomplete disingression.

### **§ 8. The Cognitive Significance of Ingression**

Since there is no knowledge without generalization, and as we see, generalization is always based on ingression (which is the result of

conjugation), we should admit that ingression provides an indispensable basis for any, true or false, knowledge, although, as it will be shown further, organizational methods are not entirely exhausted by it. Consideration of some of the cognitive applications of ingression may allow us to clarify several particular features of it which, as yet, remain in the background.

The way by which philologists discover the genetic relationships between words is well known. The main task in the study of grammatical roots is to discover the ingressive chains of mutually related words and their common source; and this source and some of the missing links can be replenished hypothetically, although in strict correspondence with the established laws of the transformation of words and sounds. Of course, we must reliably determine a sufficient number of intermediate links in order to reduce, for instance, the Russian word "земля" ("earth") and "жена" ("wife") to the common root "gen" meaning "to give birth", or to relate the German "meer" ("sea") and "erde" ("earth") to the root "mard", meaning breaking, fractioning, dividing into parts.

Let us take three words, widespread in our time; "aeroplane", "mono-plane", "bi-plane", etc. How are these words related? A majority of the public, most probably, would decide that the second part of these words — "plane" — expresses the kinship of their origin and meaning. In fact, this is not true. The second part of the word "aeroplane" (literally "wandering in the air") is genetically related to the Greek "πλανών" "to wander"; while that of the remaining two — to the Latin "planum", that is, "plain", "plane" (mono-plane literally means a mechanism with one plane, bi-plane — with two planes). Without study, the relations between the words appears to be as close and tight as, in fact, is their meaning; cognitive ingression combines them with other words and breaks off the original and apparently clear relations; "aeroplane" is drawn

nearer, for instance, to the astronomic "planet", while "mono-plane" — to the word "plan", which meant originally a plane, then — a draft on it, then — any project in general, etc.

Similarly, considering the words "tact" and "tactics", which are often overtly confused, philology is compelled to introduce them into different ingressive chains: the exact meaning of "tact" is touch, feel, from Latin "tango" — "touch"; "tactics" — construction or organizational business, from Greek "ταττω" — "to build" (for instance, a house or Army into battle order; the same is the origin of "τεκων" — architect, as well as "tektology").

It is possible to find a great many more examples like those above. They show that ingression is not only a method of conjunction, but also can serve as a method of disjunction, and, therefore, *de-organization*<sup>10</sup>. Our illustration shows only one of the simplest methods of *criticism*. However, it outlines the typical basic method of any "destructive" or "refuting", i.e. the de-organizing of cognitive complexes, criticism.

Imagine that you are meeting a peasant, who, in accordance with the old, verbal, tradition, believes that a whale is a fish. You deem it necessary to "refute" this misconception and repeat everything that has been discovered by empirical scientific criticism. You indicate that the whale has mammary glands, lungs, warm blood etc., like dogs, cows, people and other mammals; but a perch or a pike have gills, cold blood and they do not have mammary glands, etc. In other words, you create associative relationships between the idea of the whale and that of a dog, cat, horse, etc., i.e. you ingressively combine it with another type of ideas; at the same time you destroy two associative classes by compelling them to divert in consciousness. We can find similar elementary processes at the foundations of any polemical, refutational criticism, of any



"objection" in a conversation, etc.<sup>11</sup>. Schematically, they come down to the fact that some complex, which forms a part of one ingressive system, is connected with another and, being thus diverted from the first, is separated from it. But in this general form the scheme is applicable not only to ideological phenomena, but also to a vast number of practical issues in the field of technology and social organization and, finally, to the innumerable spontaneous processes of life and nature. You want to pluck a plant ingressively connected with the soil by its roots: you seize it with your hand, creating thus a new ingressive chain, then move the hand, taking it away from the soil; the plant is torn away and remains in your hand. A dentist, pulling a sore tooth, acts similarly, but the new ingressive chain is more complex: hand — instrument — sore tooth. And when a mason with a hammer breaks off a piece of granite, the method remains the same, because in the moment of the blow the hammer and the piece of granite form a single ingressive, mechanical system. The extraction of gold from rock by its compounding with mercury corresponds to the same scheme, etc.

Similarly, a man leaves one organization — family, farm, sect, party — by entering into another, which differs from the former in this or that practical aspect (spatially or by interests, intentions, world-views, etc.).

In dead nature, the scheme of a new ingression as the condition for a break with a former, is applicable no less extensively: it can be applied to a stream of water extracting stones from the river bed and carrying them away; to the wind, tearing the leaves away from trees or petals from flowers; to planetary gravitation, singling out the nearest bodies from the swarm of meteorites, etc.

In this sequence of illustrations our starting point was one of cognitive, philological relationships and then, using abstraction, we

derived a scheme applicable to all levels of being. By acting so we tried, in addition to everything else, to show clearly the extent to which tektological analysis is free in the choice of its starting point. Of course, any of the adduced examples or like illustrations from whichever sphere of experience could serve as such a point as well.

In mathematics, ingression is also made use of at every step. The well-known axiom about the equality of two values which separately are equal to a third, is, as we have already admitted, just an elementary formulation of an ingressive relationship in regard to values: the third value is the intermediate link in a chain of relationships between the first two. In the process of theorem proving, problem solving etc., the introduction of intermediate links — of course, not only in the sense of equality, but generally of functional relationships — is practised on a regular basis: in geometric constructions — in the form of auxiliary lines, in integration — by auxiliary new variables, etc.

It must be admitted that the mathematical equality of the values of two complexes, for instance two bodies, is not a direct connexion between them; it is a relation of their cognitive properties, of the concepts they are referred to by. We can say that the number of residents of some city equals that of the kilometres between the Earth and the Moon; this means that however heterogeneous are these complexes — one social, and the other purely spatial — if by certain strictly defined methods we can form ideas about them, the two ideas would have something in common: in this case, the same numeric expression. One cognitive characterization would be 385,000 residents, the other — 385,000 kilometres; the common part — the numeric scheme 385,000. Let us suppose that both complexes — social and spatially astronomic — are changing: new people arrive in the city; planetary perturbations drive the Moon further away from the Earth. As we see, the changes are absolutely

heterogeneous and their properties are incompatible; but even following them the number of residents in the city may remain equal to the number of kilometres, for instance, when both of them has grown by 100 of their counted units. This case is expressed by the axiom that if two equal values are subject to identical alterations, for instance, are equally enlarged, the equality will not disappear. However dissimilar 100 newcomers and 100 kilometres of empty ether may be, if due to them the numeric parts of the cognitive properties of both complexes have been altered identically and may still coincide: ingression is not destroyed. The same is true for any ingression: the values which correlate two complexes still correlate them if they are altered identically; for instance, the bolt and nut still fit each other if their threads are made equally deeper and wider; two pieces of textile of the same colour will not lose their similarity of colour if they are equally faded, etc.

Any cognitive characterization can be only partial and approximate, any real complex it pertains to is infinitely complicated for the cognition of its specific properties. Therefore, the mathematical expressions of the values of complexes are also partial and approximate. Were they absolutely precise, the very idea of quantitative equality could never exist. We accept that the distance between the centres of the Earth and Moon is 385,000 km; it is expressed by six integers. But in fact, not only fractions of a kilometre, but even whole kilometres and dozens of kilometres are not taken into consideration: they are "within the range of acceptable error". Were the precision of the measurement determined within microns, it would be expressed by fifteen integers; to express absolute precision, we would need an infinite number of integers. The number of a city's residents can, apparently, be determined quite precisely; but this is only because we adopt complexes which are not only heterogeneous, but even incompatible, as identical units for counting: an adult, a newly-born baby, the degenerated

personality of an old man who has lapsed into second childhood, a thinker of genius, an imbecile, an athlete, a dwarf, etc. Measurement and counting are begotten by practical organizational tasks, and they would be senseless if they were not only approximate: every value would be transformed then into an infinite expression and would remain individual, and therefore could not serve as an instrument for the establishment of cognitive or practical relationships. And the degree of approximation or the precision of quantitative definitions always depends on the specific features of the tasks they were drawn up for.

For instance, an economist, who tries to determine the value of the productive forces of a country, would be satisfied with the knowledge of the number of residents of a large city expressed in round thousands; but for the annual draft into the army it is important to take into account every single unit. For the majority of astronomical problems it is sufficient to know the distance between the Earth and Moon with an approximation of several hundreds of kilometres; but, for example, the problem of the history of relationships between our planet and its satellite requires a far greater precision, which yet hasn't been achieved.

Certainly, in our example the equality of numbers is also the result of their approximate character: while we confine ourselves to thousands, ignoring even hundreds; the two mathematical properties have the connexion "385 thousand", and no more. Let us suppose that both complexes were subject to influences which are changing them: the number of city residents was replenished by several new functionaries with their families, say, 50 men and women; the Moon under the impact of the gravity of some planet moved away from the Earth by 100 km. Formerly equal values were increased by unequal values. But we are counting in thousands, and the "linkage" (or equality) between these two values consists of thousands.

Apparently, inspite of these two complexes being altered mathematically differently, the linkage, of numerically-cognitive character, remains untouched by this alteration. This case is expressed in the central statement of infinitesimal analysis: if two equal values are increased unequally but by a value which is *infinitely small in comparison with them, then the equality is not disturbed*. The changes are infinitesimal when they, taken separately, cannot influence their numerical expression within the limits of practically adopted or practically available precision. But these are *real* changes, and it is clear that their simple accumulation can produce "finite" changes, which are able to disturb the balance.

In other words, this mathematical scheme is a particular case of an extremely simple and evident scheme pertaining to ingression in general: when two ingressively related complexes are subject to influences which change them, but which are insufficient to change their linkage to any practically perceptible degree, then the ingression remains the same; but, being added one to another, they, when sufficiently accumulated, are able to transform or destroy the linkage, and with it — the whole system.

Thus the seeming contradiction between the axiom of elementary mathematics regarding the disturbance of equality by adding unequal values and our statement about the conservation of equality in certain cases by adding unequal values also disappears. Both of them are implied by the fundamental conditions of the ingressive relationship: if the parts of complexes, which, coinciding, form an ingression, are changing dissimilarly, then the relationship is being transformed or disturbed; if the influences, although dissimilar for the two complexes, are insufficient to alter the linkage, then the ingression remains the same.

Numeric equalities show us that a cognitive ingression of concepts is possible even when such a relationship between real complexes is lacking, even when it is unthinkable: two complexes may be "equal" in some respect inspite of the complete separateness of their existences and sometimes their absolute qualitative heterogeneity. This is a universal feature of knowledge: we know for instance, that a glove "fits" a hand or a bolt a nut, although at the moment the glove is not on the hand or the bolt in the nut; we accept that the star Antares is "of the same colour" as the coals in a fireplace, although their differences and the distance between them surpass all imagination. The point is precisely that knowledge is, essentially, an *all-organizing function*.

### § 9. Social and World Ingression

The unity of social organization is comprised of innumerable and diverse relations between the members of society; the main and dominant among them are the ingressive relations. Let us study, in general form, their contents and origin.

Our usual ideas about the social relations between people imply *mutual understanding* as their first precondition. Without it, society is unthinkable; and we are used to considering — consciously or unconsciously — the degree of this understanding to be the measure of the social relations. We know that between the members of society can exist various relations of kinship, friendship, common interests etc.; but we recognize only the *particular* rather than the universally social character of these relations. For instance, watching two people which are known to share some interests, we sometimes come to the conclusion that "these people are not of the same social circle". Such is our manner in expressing that they cannot reach full mutual understanding. Let us suppose that one of

them is an aristocrat, and the other — a financier; they help and support each other in some business, maybe, even have friendly feelings and sympathy one toward the other; but they are "not of the same social circle"; meanwhile, this financier and another, his fierce competitor and enemy, are people "of the same social circle", for in fact they are able to understand each other more fully and more exactly.

What is the essence of this mutual understanding? It is contained in a common *language* and the sum of *concepts* which are expressed by this language, in what is called common "culture" or, more exactly, ideology. Returning to our illustration, the relative social heterogeneity of the aristocrat and the banker lies in the sum of ideological elements, instilled into them by education and life in their customary environment: the concepts summarizing each one's experience of "society" or, more precisely, the social stratum to which they belong, are different; and although they speak the same language, their manner of speaking is different; at least, many nuances, understandable and customary to one of them, are incomprehensible to the other and, also, the other way around. Modern society is comprised of classes and social groups which are in many respects hostile to each other; but *to the extent* that they share a common language, *to the extent* that they share common concepts, to this extent these classes and groups are of the *same* society.

So, from the ordinary point of view that we have just exposed, the linkages of social ingression are shared ideological elements. But we cannot settle on this point of view or confine ourselves to it: it would entice us into a thoroughly false idea of the *genesis* of social systems. We cannot admit that society originated from the appearance of ideological elements, shared by single individuals, for

the ideology itself could not appear other than in society, that is, on the basis of social relations, which obviously differ from it and are deeper than it.

The fundamental and primary form of ideology is speech; all other forms derive from it, for they come down to thinking or have thinking as their prerequisite; and for contemporary science "thinking is speech minus sound". So, the origin of ideology is the origin of speech; and in accordance with the brilliant theory of L. Noire the latter must be sought in the area of the *collective labour* of people.

The joint struggle for life consolidated people into gregarious tribal groups earlier than their consolidation acquired ideological forms. These forms were engendered by labour exclamations — involuntary sounds, which accompanied their labour effort, the result of the inevitable irradiation of nervous excitement in their brain centres. These yells served as natural and understandable to all members of the tribe as expressions or designations of the labour acts to which they directly pertained, being physiologically inseparable components. But for the whole group this ability to understand was a result of the collective character of labour: working jointly with others, everyone could directly perceive correlation of acts and sounds. These yells were "primary roots", the inception of speech, and then of thinking and all ideology. As we see, the ingression of shared ideological elements developed from the ingression of labour: those joint efforts directed towards a common goal. Labour ingression is the real fundament of social relations, regardless of how complicated and masked they were by further social evolution. The essence of the whole thing is the same even now; the mutual understanding or commonality of ideological elements is nothing other than the perpetual possibility of the *co-*



*ordination of efforts* of different people in order to achieve common goals. The co-ordination of efforts is the objective, vital meaning and mission of any and whichever ideology; but it is not recognized as such because co-operation in a given society is not organized in a planned manner and is interwoven with intra-social struggle: market competition and class antagonism.

Labour ingression, both recognized and unrecognized, for its part, implies a *common environment*, which is confronted by people's efforts: labour is organizationally unified when it is directed against the same sum of hostile forces or resistances. This condition is also indispensable for the appearance of ideological relations: only due to a *common field of vision* would every member of an ancient tribe perceive certain labour yells as inseparably connected to certain actions by all other members.

The unity of the field of vision is, of course, the most elementary and only partial manifestation of the commonality of the environment; in fact, the environment of collective labour is represented by everything which is called "external nature": the whole sum of activities, by which it is confronted, which are somehow available to it, which are transformed by the effort of a man or "perceived" by the resistance of his organs.

But should we regard this "common environment" as an ingressive linkage between people? Since we consider the *social organization of people*, the environment is precisely what is opposed to this organization, what is external to it and what, therefore, cannot be a linkage of social ingression; and the word "common" should not confuse us here.

However, the universal role of labour in the technological process is that relating to the organization of people and, in correspondence with its needs, labour creates the organization of things, organizes nature for people. Organizational relations are formed between people and the complexes of the environment, on the one hand, and between different complexes of the environment on the other, for instance, the relations between people and instruments and the relations between the different parts of a complex instrument, for example, a machine. For any organization of things ingression is also the fundamental, primary, form of relationship.

The field of the practical organization of things is always limited, although growing in the process of technological development and expansion. A derivative of it is the organization of knowledge, not of the things themselves, but of their symbols — concepts. It serves as an instrument of practical organization, but, at the same time, not directly encountering all the de-organizing activities, all the resistances, which are dealt with by the latter. The symbols organized by knowledge, or concepts, themselves belong to social nature as its ideological elements. Therefore, by operating upon them, knowledge is able to expand its organizing function much more broadly than labour in its technological operation of real things; and as we have already seen that many things, which are not organized in practice, can be organized by knowledge, i.e. in symbols: where the ingression of things is absent, the ingression of their concepts is still possible. Here ingression becomes universal, all-embracing.

In contemporary science world ingression is expressed in the *principle of continuity*. It is defined differently; but its technological formulation is simple and clear:

*Sufficiently extensive study of any two complexes of the Universe can establish the intermediate links which introduce them into a single ingressive chain.*

Other formulations can be reduced to this. For instance, the definition given by H. Poincare is the following: continuity is a chain, in which between any two different links we can always find a third, undistinguishable from either of them (or, in mathematical form:  $A=B$ ,  $B=C$ ,  $C=A$ ). It is clear that this is a scheme of ingression, where an indistinguishable intermediate link is a linkage, fusing with both marginal links and connecting them.

The applications of universal ingression are innumerable. The principle of continuity dominates over all the spatial and temporal groupings of the elements of the world process. The same principle has conquered casual relationships in their contemporary, i.e. energetic, combinations forming a continuous chain of all the activities of the understanding of the Universe. In biology, as well as in cosmology and the social sciences, it gave birth to evolutionary and genetic theories. It penetrates into all knowledge ever more profoundly and extensively.

Conjugation, ingression, linkage, disingression, boundary, crises C and crises D are the fundamental concepts of the tektological formative mechanism; they will serve us for the study of the most different cases of the formation of organizational forms, complexes and systems. But then, the problem arises of the fate of these formations — of their conservation, consolidation, dissemination or decline, destruction. This is the problem of tektological regulative mechanisms.

## **B. REGULATIVE MECHANISM**

### **§1. Conservative Selection**

Everything which has appeared, has its fate. Its first and most simple expression can be reduced to a dilemma: retention or destruction. Both things proceed in accordance with certain laws, so that frequently we can even foresee the fate of forms. *Law-obedient retention or destruction* is the first scheme of the universal regulating mechanism. To give it a name, it is best to make use of the term it has long been established in biology, that is, "*selection*". As concerns the adjective "natural", we shall discard it, for in tektology the difference between "natural" and "artificial" processes is not important.

The notion of selection, which has made its way in the world, first of all in biology, is nevertheless, as we admit, a universal one: organizational science must apply it to any and whichever complexes, their systems, relationships, boundaries. To illustrate this universality, let us consider several examples of the most diverse character.

Climatic change is going on in some country: the climate becomes colder. Of the plants and animals living there, some are capable of enduring this changing situation and survive, the others die. As a result, the organization of life on this territory is regulated by new conditions.

Let us now substitute for climatic change the first settling by people, who before that were unknown there. They exterminate some organisms, take away the food from others, some of them they support directly, help others indirectly by killing their enemies, etc.

This tektological occasion is quite similar to the one cited above: the organization of life is regulated in accordance with the situation. Human impact, whether deliberate or not, for each living form is an external activity — useful, harmful, or destructive — the same as is a change of temperature or humidity.

A city is subject to a fire. The wooden buildings are mostly destroyed, and the stone ones preserved. The same city is in the zone of an earthquake: multi-storied and brick buildings fall to pieces, single-storey and wooden houses remain.

The ear of a barley plant is stuck in the sleeve of a walking man. The plant gets battered from all directions; but all pressure downward is neutralized by the resistance of the ear, and those upward proceed freely: the ear of barley goes up the sleeve.

Here selection pertains to the number of complexes-events following each other in time, while the former illustrations dealt with complexes-bodies existing at the same time. But this alters not in the least the tektological scheme.

If we shake horizontally a box containing, say, irregular pieces of chopped sugar, these pieces will gradually fit so that the centre of gravity of the whole mass will occupy the lowest possible position. In the process of casual movements the motions of those pieces which raise the centre of gravity are neutralized to a greater extent than those which make it lower, because the former meet resistance not only from equally frequent casual movements in the opposite direction, but also from the permanently acting gravity of the Earth, that is, the weight of the pieces.

When a man finds himself in a grave situation, then out of the number of new sensations he holds and keeps in memory, as well as recollects, those of them which bear a gloomy and distressing character, corresponding to his new circumstances will be most influential; and the opposite case is similar: this is the selection of psychological complexes by the external environment.

In a society, its individual classes, in any collective, out of a number of newly appearing human groupings, relationships, ideas, only those are retained and preserved which correspond to the perpetual and general conditions of their life; and those which contradict them disintegrate and disappear: this is the selection of social complexes.

By comparing these diverse illustrations, we can easily see that the tektological scheme of selection differs from the "natural selection" of biology in one necessary simplification or abbreviation. Biological selection assumes reproduction and heredity; but the general organizational scheme cannot presume it, because reproduction is a particular feature of living organisms. Tektology takes from the special sciences the starting points of its constructions; but it is always compelled to alter the borrowed concepts and adapt them to the universality of its tasks. Earlier, the concept of "conjugation" was another example.

The universality of the scheme of selection consists in that it is evidently applicable to any complex and any of its parts in any moment of time, for it is essentially just a point of view, from which we can consider any fact.

Imagine an ordinary pendulum. It passes through several different positions in space; but all these positions are unstable with the exception of the vertical, which is the only one that is stable; after

several oscillations the joint action of gravity, air resistance and friction at the point of suspension will finally make the pendulum stop in the vertical position. A view, unfamiliar with tektological schematization, can leave unnoticed that this is also a case of selection, in the general and elementary sense, that we have just adopted. Meanwhile, here we have both the objects of selection — the different positions of the pendulum, and the external activities, which actually do the selection. Neither that out of the many positions possible only one can be retained, nor that these different positions cannot exist simultaneously, can undermine the applicability of the formula of selection — these circumstances are only added to it, and this is quite natural, for specific cases are always more complicated than abstractions. If we were to substitute this specific object and the conditions of selection for indifferent tokens, it would be impossible to distinguish this example from the selection of other complexes, quite similarly to how, in mathematics, we cannot tell whether a number indicates simultaneously existing objects or, on the contrary, mutually exclusive consecutive states — to ten people or ten consecutive events. In our case, every oscillation eliminates, i.e. removes by selection, some less stable (precisely, extreme) positions of the pendulum; in other cases, other complexes, relationships, correlations will be removed until "stable" states are the only ones left, i.e. those which are relatively better organized and retained by positive selection.

A man "lives", i.e. is preserved in his environment; consequently, there is a regular correspondence between him and his environment which is sufficient for it; then he dies — consequently, this correspondence ceases to exist; the cells of his body live while they are adapted to the environment, i.e. in the first place to the whole organism, and through it — to the external world, and dies, when

this correlation is to some degree violated; the same is applicable to any element of the cell, any of its partial relations, etc.

Mankind in practice constantly, and at every step, actually applies this point of view, i.e. the method of selection. Even in the special biological form people semi-consciously performed the "artificial selection" of domestic animals and crops, cultivating the most suitable forms of both of them; and they did it many thousands of years before "natural selection" was discovered: this is another illustration of the inevitable *identity* of the organizational methods of nature and people. And in a general organizational sense, all production, all social struggle, all the work of thinking proceeds constantly and steadfastly by means of selection: by systematic support of the complexes corresponding to vital human goals, and the elimination of those which contradict them.

Thus, people in all countries exterminate predators and other "vermin", breed domestic animals and protect useful wild animals; exterminate venomous plants and "weeds", i.e. plants which are useless or compete with the useful ones; cultivate useful plants which satisfy human needs. The same can be said about non-organic nature: people destroy or eliminate some complexes and preserve others; they blow up rocks, sometimes raze whole mountains to the ground, drain swamps and lakes, protect, where needed, certain river banks from erosion, reinforcing them purposely, etc. In extracting minerals and metals, people destroy some of the mechanical and chemical bonds of rocks and preserve others, which already existed or were conjugationally created by their efforts. In general, the same pertains to the production of any commodity: it implies a moment of selection, which regulates the whole process of material change on the way to a final product: a change, which corresponds



to the task, is preserved, and that which doesn't, is eliminated by a new action<sup>12</sup>.

In this form, the principle of selection is still very far from its theoretical, or generalized, formulation. The intermediate link between them is represented by special technological applications of selection, which may be called "indirect labour selection". The separation of useful from useless or harmful, in this case is performed not by direct human activity, but by other activities or resistances. One of the simplest illustrations of it is the mechanism of a strainer. The technical task is to extract from the mixture of, say, flour and bran the useful flour, on the one hand, and the useless or less useful bran, on the other. The particles of flour are smaller than the particles of bran; and both of them have some weight. When they fall into the strainer, the particles of flour continue their motion, passing through the holes, but the motion of the bran is prohibited by the resistance of the net. In reality all of this is somewhat more complicated, but the essence of the process is precisely that: a mechanism, which preserves the motion of some complexes and eliminates that of others, depending on its resistances.

The panning of gold with a spurt of water is a quite similar example; but here we must substitute the resistances of the strainer with the mechanical activities of the stream of water, and the size of the particles — by their specific gravity: water carries away the particles of quartz, clay and other matter, which are relatively light; whilst the pieces of gold, which are heavier, remain; the "selection" is of greater resistance to some type of energy.

A somewhat more complex application of the same method in technical chemistry is represented by fractional distillation, which separates the heterogeneous parts of complex mixtures and solutions.

For instance, crude oil is heated in a distilling device, say, up to 60 Centigrade; during this process the lightest hydrocarbons, which boil below this temperature, i.e. which possess the least resistance to the destructive action of heat on their molecular bonds, are evaporated and enter into a receiver; then it is heated up to 85 Centigrade — and heavier hydrocarbonates are evaporated; then up to 110 Centigrade, etc.; this is a method for the extraction of gasoline, kerosene, Vaseline, etc. The mechanism is similar to having several strainers, one below the other, with wider holes at the top and ever narrower below, through which we can run a complex crumbly mixture: the upper strainer would retain the largest particles, the next — smaller, etc.

An illustration from medicine: the chemical action of quinine destroys malarial coccids, preserving the normal elements of the blood and other tissues; this selection is the basis for treatment of the majority of infectious diseases, the treatment of neoplasms by the rays of radium, etc.

But technology is not the only sphere which can provide us with innumerable illustrations of that kind. The same method dominates in other fields of human practice as well. By means of different forms of selection people form all kinds of organizations: economic, political, ideological. For instance, a capitalist organizes working power for his enterprise by inviting those who want to be hired and laying down the conditions for it: invitation is a sort of impetus, which brings the workers on the labour market into a motion desirable for the businessman — towards his enterprise; and the conditions of employment play the role of the strainer, which admits into the enterprise workers suitable to the capitalist and detains others. In professional, political, cultural organizations the role of strainer is played by their programmes and statutes. The competitive

test is a typical example of organizational selection. In pedagogy, the entire meaning of the educator's activities is to support and strengthen some elements of a child's psyche, and to destroy or inhibit others, etc.

The struggle of classes and groups in society is always directed towards the annihilation of some social forms and relations and the support and consolidation of others, in accordance with the interests of the struggling collectives. And no less is the role of selection in the thought process, where the two aspects of it are expressed in the notions of "assertion" and "negation". Reflection, meditation, problem solving consist precisely in that out of a number of combinations, entering into the field of thought, some are approved as "successful" or "true" and others are rejected as "erroneous" or "false".

The more complex and difficult for people a problem is, the less prepared by past experience are they to know its systematic solution, the more important for its resolution is the mechanism of selection. Vivid illustrations of this can be found in the whole history of scientific discoveries and inventions: long "quests", consisting in the conjugational formulation of a vast number of combinations, which are rejected and removed one by one, until a single one remains, which fully corresponds to the task.

For the famous discovery "606" of Ehrlich-Gata the mechanism of selection was both the principle of solution and the method of search. The task was to find an actor, in this case — a chemical compound, which would be lethal for spirochaeta, the syphilitic bacterium, to a far greater degree than to the cells of the human organism. Then, by infusing in the blood a well-measured quantity of this poison, it would be possible to make a selection, so that the

spirochaeta would die, and the cells of the organism would survive and the cause of disease would be removed. P. Ehrlich and S. Gata sought this substance, testing different compounds of arsenic and rejecting them one by one as invalid, until the six hundred and sixth test gave a satisfactory result, and the nine hundred and fourteenth — in some respects even better (now there are higher numbers, which are still more perfect).

For tektological studies, the mechanism of selection should be clearly understood both as an integrity and in particular. It consists of three elements:

1) the *object* of selection — its subject matter, such as living organisms in the scheme of Darwin, buildings and houses in the example of the earthquake, the motions of things in the example of the box of sugar, the relations and correlations of things in industrial labour selection, the relations and correlations of people in the selection of social struggle, etc.

2) the *actor* or *factor* of selection — that which acts upon the object, preserving or destroying it, like the environment in the scheme of Darwin, the mechanical resistance of textiles in the example of the barley ear, similar resistances plus gravitation in the example of the box or people's activities in industrial selection, etc.

3) the *fundament*, or *basis* of selection — the aspect of the object, on which depends its preservation or elimination, i.e. those useful devices or features of maladjustment in "natural" selection, the direction of motion in the examples of barley ear and box, the correspondence to a human need in industrial selection, the correspondence to social structure in social selection, etc.

The theoretical scheme of selection has one interesting feature: from its point of view even mankind can be considered as an object of selection, whose actor is the "environment" or external nature; that is, the theoretical formula here *inverts* the original practical principle of selection, where the actor is human activity, and the object — the various complexes of the environment.

The theoretical principle of selection is already applied in a vast number of various philosophical and scientific theories. Due to the specialization of the sciences, it is manifested in different forms and with unequal clarity, because the starting points of its discovery and application were also very diverse.

The first one to formulate this principle was, probably, Empedocles, for whom it was the philosophical scheme of the explanation of expediency in nature. Empedocles thought that the art of nature was quite spontaneous and could be reduced to a blind struggle between two forces — attraction and repulsion ("love" and "discord"). Their infinitely changing correlations create the innumerable many diverse combinations of the elements of the Universe. But all of them, which are organized inexpediently, are naturally destroyed and disappear; and only those, in essence equally casual, forms remain, i.e. those which turn out to be organized expediently.

So little is known about Empedocles, that it is difficult to say where he got so general and indefinite a conception of selection from. We can only guess, considering the character of forces, which in accordance with his doctrine organize the Universe: "love" and "discord" are the relationships of social connexions and social antagonism as applied to the whole of nature. It is very probable that his experience of struggle between different collectives, particularly that of the Greek colonies with barbarian communities, a struggle

both military and economic, where the ruin of the maladjusted came about very soon, suggested the idea to the observer Empedocles (he lived in the Sicilian colonies).

The principle of selection took another shape when it was, for the first time, applied in the social sciences — although without clear formulation — by Robert Malthus. The idea of the death of the maladjusted in the process of life, proceeding on the basis of a general insufficiency of the means of life, is central to his theory. If we pay attention to the fact that Malthus' theory was an apology for capitalism, we will understand that the struggle, which dominates the capitalist market is the starting point of his scheme.

For Darwin, who has reformed biology by the notion of selection, it has already two forms: *natural and sexual* selection, with the former being, of course, the main and scientifically most important. The sources of the concept of natural selection are, on the one hand, the economic practice of capitalism — Darwin was under the influence of Malthus' doctrine, and, on the other, — the technical practice of growing domestic animals and useful plants: the production of new breeds by means of *artificial* selection.

In accordance with Darwin's views, the objects of selection are only separate individuals and through them — species of organisms. In the process of the further development of the biological sciences such a scheme has become insufficient and the concept of selection had to be extended. Physiology and pathology make use of the idea of the "internal selection" of tissues and cells depending upon the conditions of the organism, which is their environment. For instance, the interstitial palingenesis of cells resulting from some contaminations and other pathologies can be explained in that the delicate specialized tissues become maladjusted to their changing

organic environment, while the coarser connective tissues endure harmful impacts much more easily: the former tissues die, and the latter grow on their place. A similar interpretation is given to some hypertrophies, neoplasms, etc.

In psychology the principle of selection in its indefinite and general form is recognized by many specialists; and the author of this book has applied it to the study of the development of the psyche in a systematic manner.

During recent decades there have been several attempts to introduce the idea of selection into the social sciences. The majority of these attempts failed due to the vagueness of their authors' conceptions of selection: most often they take individuals and groups as the only objects of selection, thus extremely narrowing and making difficult the application of the method; even more the whole thing is usually obscured by a priori eclecticism, that is, the conviction that the principle of selection admits several exceptions, limitations, etc. But in spite of all such confusions, the results are not always negative, and given a correct understanding of social selection, which we have had to expose in other publications more than once, it gives a secure basis for the explanation of social processes.

An especially broad area for the idea of selection is provided by the problem of ideological development; linguists have already used it in their special field; some philosophers, such as G. Simmel, have recognized its utility in the study of conceptual change. In this case, the lack of clarity of the fundamental scheme did not allow him to reach positive results and the whole thing was mainly reduced to general discussions.

In physics and chemistry W. Crookes had already in the [eighteen] seventies tried to introduce the idea of selection as a method of explanation of the origin of the elements of matter. He considered existing atoms as the most stable and therefore the ones which were preserved out of the innumerable possible combinations of prime matter. Now, when the complexity of atoms and the existence of concentrated motion inside them are beyond doubt, the ideas of W. Crookes get new support and we can expect their further development, however, with the elimination of the notion of "prime matter".

So, the same principle struggles its way forward in the most different special branches. But as a consequence of this specialization its development lacks unity; it appears in many variations containing many nuances, whose relations and correlations remain unclear. The unity of the method is evident, although its transfer from some spheres to others lacks systematicity and is more or less casual, so that the results are often insignificant where, with more conscious application, the method could be very useful.

This is the task of tektology: to integrate the uncoordinated, to elaborate the universal organizational method, whose applications would all be variants of selection in reality and theory. For this, our first, abstract generalization is insufficient. Let us study it in more detail.

The first scheme of selection, which treats only the preservation or non-preservation of organizational forms can be referred to by the term "*conservative selection*".



## § 2 Dynamic Equilibrium

Tektology deals only with activenesses, and they are always defined as producing change. From this point of view a simple and pure "conservation" of forms, which would be a genuine absence of change, is out of the question. Preservation is always only a result of the process where each of many changes are counter-balanced by equal and opposite changes; this is the *dynamic equilibrium* of change.

In its life activity, an organism is constantly expending, *wasting*, by turning over to its environment, its activenesses in the form of the substance of its tissues or the energy of its organs. This does not prevent it from remaining — approximately or practically — "the same", i.e. it is conserved. In exchange for the waste it also constantly takes, *assimilates* from the environment the elements of its activenesses in the form of food, energy, external impressions, etc. In the course of weeks and months it thoroughly renovates the composition of its main, most suppliant tissues, and in the course of a few years — even the composition of its skeleton. It is conserved in the same manner and in the same sense as the form of a waterfall in the process of constantly changing its water. This is what the dynamic equilibrium of the material and energy exchange between organic and non-organic complexes and their environment means.

In nature, it can be found in multiple forms; it alone provides the opportunity to find there whichever kinds of stable complexes, which alone make knowledge in general thinkable. And with the growth of knowledge, it was more and more frequently found that when a naive perception conceived only stability and invariability, it was only motion that existed, that the static illusion is created by two currents of opposite changes. The temperature of a body remains the

same only if it releases to the environment the same number of thermal oscillations as its receives from it, and the neutral electrical charge of the things surrounding us is possible only under similar conditions of the exchange of electrical energy. The sea continues to exist by means of the rotation of water, which it provides to the atmosphere in the form of vapours, and which, in the form of precipitation, it receives from streams and rivers, which bring back to the sea the precipitation over dry land; in the atmosphere, there is a similar rotation of gases, sustaining its chemical composition, etc.

With the progress of scientific research, all kinds of chemical stabilities are gradually reduced to an equilibrium of opposite exchange relations; and there are many reasons to believe that the same thing will happen in relation to the stability of electrons and the energy composition of atoms.

Until recently dynamic equilibrium was believed to be a special feature of living bodies. Biologists have given to its two aspects, its two constitutive currents, the names *assimilation* — *de-assimilation*, or literally — "identification — de-identification". The former means the assimilation of elements taken from the environment, when they, being introduced into composition of a given complex, create there groupings "identical" to its other groupings and resembling them; the latter — de-assimilation of elements, their release into the environment, their coming into combinations, which are dissimilar and different from those they have been in before. Of course, our usage of these words pertains to all organized complexes, to all possible tektological forms.

Dynamic equilibrium can never be absolutely precise: there cannot be a full, unconditional equality of opposite changes; it is always only approximate, practical; in other words, dynamic equilibrium or

the conservation of forms can be claimed to be the case when the difference between assimilation and de-assimilation is sufficiently small as to be ignored, and the complex considered as "the same", as conserved, only within the limits of the period of the task to be fulfilled. For instance, when we consider a man as working power, we can accept him as conserved, a constant value within weeks, months, sometimes several years, and no more; but for precise physiological studies things are different, and we can observe perceptible, and important to scientific calculation, changes in this or that direction within the same time limits,

We recognize a newly-born baby and the adult man, which he has grown into 30 years later, as the same human being, though their objective and subjective differences are much greater than those between two babies; and the reason for it is that at any given moment the changes of growth remain unnoticed.

Tektology must consider any case of the conservation of forms as the result of their dynamic equilibrium, and any occasion of dynamic equilibrium — as the practical relative equality of the two processes of assimilation and de-assimilation.

### **§ 3. Progressive Selection**

So, precise conservation is impossible, and approximate conservation implies only practically small changes towards the prevalence of assimilation over de-assimilation, or the other way round. This alone makes the scheme of conservative selection scientifically insufficient. But not only this. It makes problematic the explanation of those cases when a form changes by progressive development; to call them "conservation" would be inaccurate and,

of course, they are not cases of destruction. For instance, we know that a baby is not just conserved but is *developing*, and this is the condition of his survival under the complicated impacts of the environment. If the baby ceases to grow, we see nothing good in that he remains as he is, but quite the contrary, we assume that his viability has decreased, that he is threatened by degeneration. And, generally, it can be easily proved that the real conservation of forms in nature is possible only by means of their progressive development; without it, "conservation" imminently reduces to destruction, which, though, due to its slowness, can remain unnoticed by routine methods of observation and research. And the majority of the "conserved" complexes of our environment exist in this very situation: they are slowly and elusively being destroyed.

One Eastern tale interprets the notion of eternity with the following comparison. At the edge of the world there is a diamond mountain, the size of which is a one-day journey in length, width and height. Once in a hundred years a little bird stops at the top of it and cleans its beak against the mountain. When by the repeating of this operation the whole mountain has been eroded to its foundation, then the first second of eternity will have passed. Of course, this illustration does not clarify eternity, for this is a negative concept. But certainly, if the mountain does not suffer any erosion other than has been mentioned here, then, although from the practical view it will be conserved for a very long time, a precise theoretical formulation would regard it as a complex which is being destroyed. It is quite probable that the atoms of some chemical elements are destroyed even more slowly than the diamond mountain; but in the contemporary theory of the composition of matter there is only a *quantitative* difference between the decay of these elements and that of some emanation with a mean period of life of only a small fraction of second<sup>13</sup> — there are indications of the existence of an

emanation with a period of one hundred-billionth of a second. Rapid or slow destruction may be very important to us in practice; but to scientific analysis it is only a difference in one co-efficient.

Let us suppose that we succeed in proving that complex *A* is not destroyed at all, and besides this, does not experience changes in the opposite direction, in the sense of the prevalence of assimilation over de-assimilation, i.e. the accumulation of the sum of activities. In this case we would have pure, ideal statics; but it is easy to prove that it could not exist indefinitely and would eventually come to be destroyed. Complex *A* belongs to a given specific environment and stands in full dynamic equilibrium with it; and only inasmuch as this environment remains the same, is the equilibrium secured for it. But the environment can by no means be as unconditionally stable: it is connected with the flow of world events; strict analysis will show that finally it spreads to the whole Universe; therefore, it is *necessarily* changing. Clearly, the relations of the complex *A* with its environment are then also changing. Can these changes be favourable for it? Yes, but only casually and therefore temporarily. Generally, changes of environment, which proceed independently from the complex, are much more frequently *unfavourable* to it; because, as is shown by the whole of human experience, the number of unfavourable possibilities is much greater than that of the favourable; it can be illustrated in the probability that a ship left without sails and rudder would be brought to where it is needed. Therefore, in a changing environment the static position of the complex *A* inevitably turns into one unfavourable to it, that is, the prevalence of losses over assimilation, its gradual downfall.

So, for conservation in a changing, or, in the final analysis *any*, environment, a simple exchange equilibrium is insufficient. The only thing which can provide a relative guarantee of conservation is

an accumulation of the sum of activities, the prevalence of assimilation: then, new unfavourable impacts meet not the past but increased resistances. This is the method which nature uses for the conservation of living forms, and people — for their collective conservation: by the growth of complexes, the accumulation of the stock of activities. Each step in this direction improves the possibility of supporting life in changing conditions. In other words, the *dynamic element of conservation* of a complex is the accumulation of activities at the expense of the environment.

Similarly, the dynamic element of destruction should be represented in the form of the reduction of a complex's activities, of their waste into the environment. The fact of the destruction of a complex, of its disappearance is the result of a process, which sometimes is very complicated but which is, from the quantitative point of view, manifested exactly by the reduction of activities-resistances. Destruction can be perceived as "instantaneous", for instance, the splintering of a block under the impact of a steam hammer or the halt of the life of an organism by a thunderbolt; but this is only a result of the imperfection of our sense organs. Theoretically, i.e. scientifically, each such event can be decomposed into a continuous sequence of events, which gradually reduce the sum of the elements of the complex. The rupture of connexions, which constitutes the substance of the process, arises, as we know, from disingressions which paralyze the complex's resistances with activities opposite to them, and which are destructive, and tektologically "external"<sup>14</sup>, to it.

Each of these disingressions is developed by means of a gradual invasion by external activities — whether rapid or slow, for the general scheme is unimportant — an invasion which is paralyzing,

withdrawing, *de-assimilating* the proper elements-activities of the complex.

Now we approach a new understanding of selection, based on the idea of dynamic equilibrium and deviations from it. This scheme is broader and deeper; it covers both the progressive development of complexes and their relative downfall; it decomposes the processes of conservation and destruction into their elements. The most expedient way of expressing it is with the term "progressive selection": *positive*, when the sum of activities of a complex grows, i.e. assimilation prevails over de-assimilation, and *negative*, when the sum of activities is reduced, i.e. when what prevails is de-assimilation<sup>15</sup>.

Here is one of the simplest examples of such selection.

In the cavity of a leaf there is a drop of water. Water molecules, being "evaporated", are continuously removed from its surface into the air (de-assimilation), and at the same time other molecules are precipitated onto it from the atmosphere (assimilation). In an atmosphere saturated by water both processes are equal, this being an actual dynamic equilibrium. When the air is oversaturated with water, for instance, due to the lowering of temperature, precipitation prevails and the drop grows; this is progressive selection in the positive form. When the saturation of the atmosphere with vapour is incomplete, then evaporation prevails; it strives to destroy the drop; this is the negative form of progressive selection.

Other examples: the growth of a cell in a favourable environment, which provides it with a prevalence of nutrition over the waste of substance and energy; the gradual reduction of the substance of a

cell, its "emaciation" in a scanty environment. The growth of society as an organization of human powers, when production outweighs consumption; the reduction of the sum of social activities in the opposite case. The growth of the temperature of a physical body, when it absorbs heat to a greater extent than it releases it into the environment; its reduction — when losses prevail. The amplification of a tone emitted by a resonator, when it receives more energy in the form of waves corresponding to its period and, therefore, assimilated by it, than the energy that it sends out in the form of the waves emitted by it; the decline of the tone under the opposite conditions, etc.

The results of progressive selection are manifested, first of all, in the *growth or reduction of the number of elements of the complex*: the growth or reduction of the elements themselves would be the same, if we were to properly analyze them further, by decomposing them into ever smaller and simpler units. For instance, the positive selection of an adult organism can be accompanied by the growth of its cells themselves, rather than of their number; but this implies the growth of the chemical and physical activities of the cells, and consequently, of the organism as a whole. But these quantitative results of selection are far from settling the matter.

A drop of water has the form of a slightly flattened ellipsoid, resembling a sphere. This form is determined by its general structure, particularly, by the proportion of the weight of the particles to their adhesion: this adhesion makes the surface layer resemble a kind of strained pellicle, which sustains the form of the drop. In air oversaturated with water the size of the drop grows; but precise observation can easily prove that its form is also changing; it becomes ever more flattened. This, certainly, means that the *structure* itself is changing. If this positive selection is continued,



then the flattening of the ellipsoid will be accompanied by stretching along the axis; finally the drop will be torn. The accumulated changes of the inner structure have led to a crisis.

Negative selection — in our example, the gradual evaporation of the drop — also changes its form, attesting also to changing internal correlations. The form of the drop becomes ever more regular, ever more close to that of a regular sphere; and finally, the progressive reduction of size of the drop results in its disappearance: this is another crisis.

The same pertains to any other case of progressive selection: with the accumulation of the wastage of old elements, the structure of a complex, its inner correlations, are what is changing. In a living cell, the processes of growth change the molecular bonds, manifested first in some variations of form and then — by its separation into two identical daughter-cells, or by the separation of some of its parts by means of "gemmulation", etc.; when the influx of matter and energy to the cell is insufficient, the change of form is sometimes followed by its destruction, sometimes — by the formation of a protective coat around it and a slackened metabolism, sometimes — by the formation of spores possessing similar coats, etc. The prevalence of the assimilation of thermal energy over its loss also leads to the transformation of molecular bonds, causing chemical reactions. Everywhere we observe growing changes of structure, which, at a certain level turn into crises.

We can also determine, in the most general form, the character of these changes of structure. We observed that in the process of positive selection the form of a drop becomes less regular and geometrically more complex. At the same time, the drop becomes

more easily divisible into parts, its resistance to a break being relatively reduced; and provided its size is sufficient, it is broken by the force of its own weight<sup>16</sup>. Obviously, all of these point to the *growing complexity and inhomogeneity of the inner correlations of the complex*. This is true for all other similar cases, and is understandable *a priori*: Newcomer elements, breaking into former relations, certainly complicate them and deprive them of homogeneity, inasmuch as it existed.

Under negative selection the form of the drop becomes geometrically simpler and more regular, and its resistance to breakage becomes relatively greater. This points to the *simplification of the inner structure and growth of its homogeneity*: A tendency which is the opposite of the former. And it is as easily understandable: under the impact of the environment first of all the elements which were less firmly bound, and the bonds of which reduced its homogeneity, take leave from the whole. And together the reduction of the number of bonds and the growth of homogeneity mean, precisely, the simplification of structure.

This characterization is applicable only within certain limits, i.e. while such selection does not result in a crisis; then the comparison is hampered in that the form itself is recognized as qualitatively other than it was before; and the direction of selection may abruptly change. For instance, the capitalistic industrial system of production has certain properties under the conditions of positive selection — so called "prosperity"; but during "industrial crisis" these properties are not only abruptly substituted for other properties, but also the direction of selection becomes negative<sup>17</sup>.

Although, as we saw, the conservative scheme of selection is less viable than the progressive, it does not follow that the latter should

always be recommended as more proper and expedient. Both in practice and in theory it especially concerns the problems of the *development of given, actual complexes*. Therefore, it is especially important and useful, when such development actually depends on our actions or where it is a subject of theoretical study. As an illustration of the former case it may serve pedagogy, whose task is precisely to control the development of the organism into a future member of society, to direct and manage this process systematically. An illustration of the latter case is, in psychology, the theory of the formation of an individual psyche, in the social sciences — the theory of economic development, the theory of ideologies, etc.

And in cases when actual complexes — in accordance with the nature of a practical task under study — do not the least bit perceptibly develop in some direction, but only serve as a ready material for more complex formations, we have to use the scheme of conservative selection. It can be illustrated in many practical cases when we have to extract from available material that which fits our task: gold from a deposit or ore, workers for a certain business from a mass of applicants, the best means and methods from a number of available ones, etc. In theoretical fields, it can be illustrated by such cases from mass statistics as the propagation of waves accompanied by the mutual destruction of the vast majority of vibrations and the preservation of those, which go along certain lines; impacts causing abrupt changes to flora and fauna; the impacts of historical disasters on the structure of society, etc.

The original scheme of progressive selection again was provided by human practice, namely, the technical process. It proceeds by the constant expenditure of energy, in the form of labour, into the environment, and the continuous assimilation of its elements, at the expense of which social life is supported and developed. Here, in a

changing environment, the simple conservation of life as it is, is essentially insufficient and will inevitably be transformed into its destruction: a society, which cannot expand and reinforce its labour influence on the environment, because its assimilation of energy does not exceed its waste, is doomed to downfall and degeneration. The formula "expenses — acquisitions" (de-assimilation — assimilation) is then extended by science to all life processes; this is the "dynamic equilibrium of life"; the prevalence of assimilation is the condition of growth, development, progress of life, and therefore, its preservation in a changing environment. Furthermore, the concept of dynamic equilibrium can be extended to the non-organic world; for instance, in the study of thermal complexes it is assumed that each body at the same time releases thermal energy into the environment and receives it back from it; when both currents are equal, we have thermal equilibrium, when they are unequal — heating or cooling. To an ever greater extent science manifests the aspiration of considering every stable form as a result of the relative equilibrium of opposite currents of energy in both material and immaterial forms, i.e. as a replacement of substances or exchange of "energies". These ideas should be naturally accompanied by the idea of that selection which we have called "progressive".

By the way, here is manifested the whole complexity of the mechanism of selection. Owing to the historical course of scientific development, the concept of selection was introduced in tektology, being almost ready-made, simple and habitual to contemporary thought. In reality, the most elementary acts of selection can be decomposed into various processes of conjugation and disingression. Moreover, they always go alongside each other. For instance, the positive progressive selection of some system means the growth of the sum of its energies by means of their assimilation from the

environment. The assimilation itself is, of course, an act of conjugation; but the assimilated activities must be *torn away* from the complexes of the environment they belonged to; and this tearing away implies disingressions. Therefore, the regulating mechanism of selection is a particular combination of the formative tektological mechanisms, rather than something disconnected with them.

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<sup>1</sup>In biology this term denotes the act of coupling of two freely living cells, that is, it is a prototype and a germ of sexual reproduction. Properly "conjugation" means that two cells couple temporarily and partly (they usually exchange a quarter of their nuclear composition), while so called "copulation" is their complete fusion. Both cases are usually followed by the process of the cell's division and every newly appearing cell inherits the combined properties of both sides. Thanks to this, propagation turns out to be the creation of really new forms and not the mere replication of old ones. It is this fine point, latent in reference to creation, which makes the term "conjugation" in its universal generalized meaning the most suitable for tektology: from its point of view the origination of new forms is always based on the joining of already existing complexes and any connection always leads to the origination of new forms.

<sup>2</sup>To avoid any vagueness I should note that the matter here is not purpose as a subjective notion, which is separate for each collaborator and may differ in many respects, but it is *the objective tendency of efforts* which is the real common element establishing the base of the organizing of the collaboration. The notion of purpose may be identical down to the smallest detail, and nevertheless there will be no collaboration or organizedness if there is no common orientation of activities. In this case the men pursue the same goal "independently" of each other, and the total result of their actions will not exceed the simple sum of their individually achieved results (frequently it is less than this sum).

<sup>3</sup>Certainly, this is the case only if division does not involve changes of the cell's general structure. In the world of unicellular forms nature often resorts to fission

precisely when unfavourable changes of the environment occur, e.g., under a deficiency of nourishment, as is observed with sporophytes. But then the very structures of living forms undergo sophisticated changes: a spore is not a mere piece of the original cell, its chemical exchange with environment is nearly stopped, attained by the drying of the plasma, as well as producing an extremely durable shell. Due to that the stability of its organization is comparatively great and enables the spore to be well preserved for a very long time until favourable conditions for development return.

<sup>4</sup>It is really *quite* opposite to ingression. During ingression activities which were not connected earlier join together forming a "linkage" of conjugating complexes. During disingression they mutually paralyze one another, which results in the formation of a "boundary", that is, a separateness. While they are not completely paralyzed a boundary is lacking: this is only a *partial disingression*.. It is always mixed in with any ingression because, as we saw, the conjugation of complexes is impossible without some wastage of their activities in the form of mutual resistances.

<sup>5</sup>The division of a propagating cell occurring spontaneously also evidently evolves along the lines of its internal disingressions and *may*, too, not be a de-organizational act in its immediate nature. However, it may be de-organizational and, at the same time remain a primarily organizational process in its outcome, in its significance for the development of the living form. If a river hydra is cut into pieces capable of regeneration this is undoubtedly a directly de-organizational act, but it is an act of artificial reproduction as well.

<sup>6</sup>Those criteria are often disguised. For example, the problem of divorce is regarded from the viewpoint of "morals", "duty", "honesty", and so forth. Behind these notions the organizational forms of diverse social systems are concealed. For instance, feudal "honesty" is the standard of organizational relations within the aristocratic estate, Phillistine "duty" is the standard of the bourgeois classes' relations. The break-up of a marriage may be in disagreement with feudal honesty as it partially destroys the family-ancestral mode of the organization of this estate; the breakage of the relation between the vassal and the sovereign oppressing him is also in disagreement with it as it undermines the authoritarian structure of this organization.

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<sup>7</sup>Sailors represent this mental operation in the specific symbol of Neptune, who brings the travellers crossing the equator to a stop. In order to overcome the resistance, there is need of additional activities in the form of treating Neptune (represented by a dressed and painted sailor), the paying of a redemption to him, etc.

<sup>8</sup>That is, "conjugational", uniting, and "disjunctive", dividing.

<sup>9</sup>With regard to these illustrations maybe it would be useful to remind oneself that the concept of the "conjugational process" in tektology is purely formal; it pertains to any fusion or blending of whichever activities with no incidental idea of its "peaceful" or "friendly" character, as well as with no hint of a necessarily "material character". For instance, a battle skirmish, the mutual seizure of captives, weapons or ammunition by fighting Armies from this point of view are phenomena as conjugational as the merger of two organizations, the fusion of two streams, the exchange of labour and goods between people, etc. The action of heightened air pressure on the mercury of a barometer is also an energy conjugation, although the "material" blending of the mercury with the air is not observed. The kinetic energy of air particles "streams" into the system of the movements of the molecules of mercury and alters it, producing a forward movement of the whole of the mercury contained in the tube; and the other way around, the oscillation energy of the mercury particles is transmitted to the adjoining, and then other, particles of air, "merging" with their movements and changing the magnitude and form of their orbits. The actual types of conjugations are as infinitely diverse as their outcomes.

<sup>10</sup>In our examples de-organization is only relative and incomplete. The broken direct relations of assonant and closely related in meaning words can be substituted by relations that are indirect, coming through a vast number of intermediate links from their common ancient Aryan roots, which in both cases can combine the departed Greek and Roman roots.

<sup>11</sup>This is the *fundament* of the phenomena; but I must remind the reader that it isn't entirely exhausted by it. In all cognitive and ideological processes there are other forms of organization in addition to the simple chain ingression.

<sup>12</sup>However, labour cannot be *fully* reduced to selection. Similar to the selection in nature, labour is always directed towards the preservation or destruction of certain

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forms; but while the former is based on the "variability" of forms, which doesn't directly depend on it, the latter not only makes use of the transformations of objects proceeding independently of it, in order to preserve useful and eliminate detrimental of them, but also *produces* these transformations; for instance, a farmer not only makes use of the fact that a seed fallen onto the ground gives birth to a new plant with a multitude of new seeds, but also sows them himself. The method, by which he produces these changes is, of course, the *conjugation* of his own activities with the complex of external nature.

<sup>13</sup>An editors' note to the 1989 edition of the Tektology (p. 200, Book 1) suggests that Bogdanov is referring to isotopes of Radon (Rn), — Eds..

<sup>14</sup>In tektology, the word "external" is not used in the spatial sense. Bacteria in an organism, "poisons in its blood" are, in an organizational sense, external, rather than "internal", complexes because they do not belong to the system of its organizational relationships. And those parts of a system, which are beyond its organizational framework, even when spatially contained within it, should be considered as tektologically external. For instance, cancer cells, tissues which develop in contradiction with the life relationships of an organism; a criminal, whom the society fights as an external force, etc. But in this case, as in all other cases, it is also "inasmuch as": the organizational framework is relative; the criminal, for instance, is beyond this framework only inasmuch as he violates it; in all his other activities he may still belong to it.

<sup>15</sup>The word "selection" ("подбор") here, probably, deviates from its original meaning; but it always more properly expresses the inner meaning of the correlations under consideration and their relation to the previous scheme. "Progressive" ("прогрессивный") here originates not from the word "progress" ("прогресс"), but "progression" ("прогрессия"), i.e. a continuous sequence of events, going on in this or that direction.

<sup>16</sup>The reason is that the form of the drop is sustained by the surface layer of molecules, by its tension. But this surface layer (in accordance with the laws of geometry) grows more slowly than the volume and, consequently, the weight of the drop. And it is the weight of the particles, on which the deformation of the drop depends; therefore, it



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grows faster than the resistance of the surface layer; the proportions between them determine the changing form of the drop and, when its weight outbalances the coupling force of the surface layer, its disintegration.

<sup>17</sup>In mathematical analysis there is a special symbol for the expression of the progressive selection of "values"; this is the *derivative function*. When this function is positive, it means a positive selection, when negative — a negative one. When it is reduced to zero or infinity, i.e. interrupted, or inverted, it expresses a crises of values. The simplest illustration: in the process of the motion of a body the time derivative of distance is velocity. When it is more than zero, the distance grows, when it is less than that, it decreases; when it is zero — this is *crisis of cessation* of the motion, etc.

# Chapter IV

## The Stability and Organization of Forms

### §1. Quantitative and Structural Stability

A drop of water in an atmosphere over or under-saturated with vapour provides an example of positive and negative selection. It may also be considered as an illustration of two basic notions pertaining to the conception of the organizational stability of forms.

When the air is not saturated with vapour, the drop evaporates and emits its elements into the environment. Under these conditions, over a certain period of time, it will completely disappear: this is the crisis of the destruction of a given complex. Assuming that the humidity and temperature of the atmosphere do not change, the duration of the existence of the drop depends on its size: a larger drop will remain longer than a small one. Complexes which include larger sums of elements can be considered as *more stable* in regard to their environment, but certainly only in a purely *quantitative* sense, as they possess a larger sum of activities-resistances confronting the environment.

Clearly, positive selection leads to the growth of this "quantitative stability", and negative — to its decrease; or, to put it more exactly, positive selection is equivalent to its growth, and negative — to its diminution, for the former can be defined as the outbalance of assimilating over de-assimilating processes, i.e. as the growth of the number of elements of the complex, and the latter — in the opposite way.

But the real, practical stability of a complex by no means depends only on the number of activities-resistances which it has concentrated, but on the kinds of their combinations, on the character of their organizational interrelationships as well. We know that positive selection results not only in the growth of the size of drop, but also in the greater inhomogeneity of its structure, for example, it facilitates the mechanical splitting of the drop, such that, at a certain point, it can be split into two by its own weight. This is an example of the decreasing "structural stability" of the complex. On the contrary, negative selection, by diminishing the size of the drop, leads to the strengthening of the homogeneity of its structure; and being it as it is, relatively more force must be applied to it to cause it to break: its "structural stability" increases. Of course, this is true only within certain limits, while the basic structure of the drop remains the same, i.e. until a crisis breaks out, which is inevitably produced by negative selection if it is long enough, — in our case, until the crisis of the "disappearance" of the drop as a liquid body.

Structural stability itself is a mathematical value, and it can always be expressed numerically. Thus, in mechanics, the coefficients of resistance to bending, breaking, twisting etc., are nothing other than numerical expressions of the structural stability of various bodies in regard to certain external influences. As concerns the notions of "mass" and "energy", they express quantitative stability.

Two complexes of the same type, comprised of similar elements-activities, can be directly compared by their quantitative stability, with no attention being paid to the peculiar influences of their environment: if complex *A* contains more elements than complex *B*, then it is in any case more stable in regard to external influences of whatever nature. For example, as an organism grows, its resistance to the contaminating influences of poisons is also growing; and whatever poison it may be, there will need to be a greater amount of it for the de-organization of a larger number of tissues. On the contrary, structural stability should always be investigated in regard to particular rather than general influences; an organism is more resistant to one poison than to another, etc.; and for every destructive influence the coefficient of resistance is different.

However, sometimes the notion of structural stability can be applied in a less definite form. If complex *A* is surrounded by a more or less stable environment, being subject to a certain sum of influences, which are variable only within certain limits — a man in his social stratum, animals or plants in their usual natural settings, etc. — then it is possible to form a summary idea of their stability in regard to the whole system of influences. So, by comparing two different political or cultural organizations, which exist within the framework of the same society, we can discover that the structure of one of them is better adapted than that of the other, i.e. structurally it is more stable. But when a society is exposed to sudden changes — for example, revolutions, wars, crises of production — the correlations may turn out to be different, sometimes quite opposite to expectation.

Contemporary theories of the structure of matter suggest that all atoms are gradually destroyed in their natural environment, although as yet there is no clear understanding of the character of the destructive influences. However, we know that the average

length of the life of radium is approximately 2500 years, of thorium — about 40 billion years, for mesothorium — 8 years, and of some emanations — minutes, seconds and slightest fractions of seconds. These figures represent the summary coefficients of the structural stability of given forms of matter in their usual environment, where we observe them and whose boundaries cannot yet be transcended by experimental practice. When the impacts which determine the speed of the destruction of atoms is understood, and we are able to alter this speed for different bodies, then not only will we be able to resolve the theoretical problem of the conditions of their structural stability, but in addition mankind will be practically provided with the opportunity to operate with the giant amounts of activeness of "intra-atomic energy".

The concept of structural stability within an environment which is variable only within certain limits is very important for tektological practice. The whole environment of life on Earth, the environment, in which mankind acts and develops, with its usual amplitude of the oscillations of its different factors in astronomic, atmospheric and other cycles can be considered as limitedly variable, i.e. one, whose variations can be accounted for by science — either in their totality or in broad summary combinations.

Particularly, it is very important to know how progressive selection — either positive or negative — influences this structural stability. As we saw when we considered the drop of water, positive selection, by increasing the inhomogeneity of the internal relations of the complex, leads to the *diminishing* of stability, and negative selection, by strengthening this homogeneity, causes the *growth* of stability. The same thing is true for any complex operating within an environment of indefinitely-variable and diverse impacts: in the first case, the existing structural contradictions are conserved and extended with the addition of new elements; in the second, the

process of destruction cuts out from the complex those elements which are least firmly associated with it, and breaks the most contradictory, mixed interrelationships with partial disingressions. For example, the growth of a living cell, like the growth of a drop of water in a saturated atmosphere, leads to the accumulation of internal disingressions, which here also culminates in the splitting of the cell into two; in biology this split is called "reproduction"; but the drop, which has disintegrated in the saturated atmosphere, is also "reproduced", for its parts, the "daughter drops", continue to grow in the environment like their mother did until they too disintegrate again; and the same thing occurs in cases of the "reproduction" of liquid crystals, etc.

This regularity may be observed especially clearly in the cases of organisms and society. If, for example, a man lives for a long time in a most favourable environment, then, inspite of his quantitative accumulation of energy, his total resistance to the environment becomes lower, or, as people say, he "becomes effeminate"; and this means precisely the diminishment of his structural stability in regard to unfavourable external impacts. On the contrary, moderate starvation, blood loss or fever are often followed by recovery to a state which is healthier than the organism was before the process of negative selection; and "health" is just another name for the structural stability of the organism.

Pathology explains this fact in the following way. During fevers, starvation or injuries, the whole organism is affected by microbe contamination or undernourishment, or by an unusual loss of vital energy in general. If, inspite of this, the organism still survives, it survives only as a whole: a number of its elements have died; and they, inevitably, were the least resistant or possessed of the least quantity of vital elements. This loss can be beneficial to the organism. The more viable elements get more space for their

development, and when assimilation becomes prevalent over losses, they grow and are reproduced at the expense of the less powerful: thus the general viability of the organism increases.

Physiology and pathology generally regard cells as the elements of the organism, and they apply schemes of selection like the one cited above only to them. However, by adopting a tektological view, we can apply the same scheme to any kind of elements which can be discovered in the system, by practice or by thought: to cells and their parts — both to individual albuminous molecules and their special combinations, as well as to the dynamic correlations between them. Besides, the picture of negative selection and its outcomes becomes thus fuller and clearer. For example, the growth of the vital stability of cells can be achieved by their internal selection, apart from the death of the weakest of them. Indeed, when the energy of a cell decreases, in the initial stages of the process the disintegration encompasses only those of its parts along with their correlations and combinations, which are least resistant to the destructive influences of the environment; and the whole of its composition and structure becomes more stable at the expense of its size and internal complexity, whose reduction, however, is only temporary, ceasing with the recovery of the organism. The same can be said about correlations and combinations between individual cells. The growth of the organizational stability and durability of a system is based on the *simplification* of its internal relations, called forth by negative selection.

However, the impact of negative selection on the living complex, which has been just described, is only a possible, and by no means inevitable, outcome. Firstly, beyond certain limits the gradual reduction of energy and simplification of the system invariably leads to its *degeneration*, or steady decline. For example, progressive reduction of energy, which is very common in the elderly, leads

little by little to the most unbeneficial simplification of the organism: the most differentiated tissues of the organism die, and the less differentiated — the cells of the connective tissues — are reproduced at their expense, although the latter cannot execute the functions of the former, and the whole organism finally dies. The cells of nephritic or neural tissues in certain aspects, i.e. in relation to certain activeness and external resistances, are organized better than those of the connective tissues, and therefore they are more rather than less viable; but due to their specialization, i.e. their adaptation to special, particular conditions and functions, they exert less resistance to the various external impacts called forth by a lengthy weakening of the organism than connective tissues. The latter can be found in the most diverse parts of the organism, among other sorts of tissues, and therefore they can endure multiple and changeable negative influences under very different circumstances; correspondingly, their organization is simpler and more stable than that of other kinds of tissues. Negative selection destroys these cells in the last instance; nevertheless, even they cannot survive without the other elements of the organism.

Secondly, and equally important is the kind of influence which leads to the process of negative selection. If an impact significantly deviates from the usual influences within which the organism has developed and lived with in general, it will be more destructive to the less viable elements. The notion of viability is relative; it is meaningful only in relation to this or that environment; and elements, which are highly adaptive to some environment and resistant to its impacts, may prove, and on most occasions do prove, to be less adaptive and resistant to another environment or different kind of influence. For example, even an insignificant contamination of the organism from some poison which has no chemical kinship with its natural alkaloids or other usual external or internal poisons,



will only occasionally cause the subsequent improvement of viability, most often it will end in the opposite.

Let us now take an illustration from the realm of the most complex living systems, i.e. social ones. The stage of positive selection corresponds to a period of the economic prosperity of a society, when it takes more for production and consumption from its environment than it spends in any manner, when, using economic terminology, the "wealth" of the society grows. There is no need to prove that the complexity of social life and the inhomogeneity of its elements are also growing during this time. People, enterprises, groups and organizations expand their activities, needs, experience; the number of individuals and their groups grows by means of reproduction, the organization of new enterprises, the establishment of new relationships. Everything new is preserved and growing, but the old elements are not destroyed; in this sense, positive selection is conservative; economic prosperity does not lead to general prosperity, that is, the comprehensive reconstruction of the social structure or profound social reforms; society, we may say, lives in the present and is satisfied by it. Differences between people and the divergence of their groups increase: enjoying relative well-being, each one develops in the direction of his special inclinations; and so the economically more powerful groups and individuals take more advantage from the prosperity than the weaker ones, inequality also grows. This complication of the vital relationships and the growth of their inhomogeneity diminishes the harmony and stability of the whole system. For example, England in the period of its domination of world markets during its centuries of prosperity was remarkable on account of its economic extremes. It was a country where tremendous fortunes went along with appalling poverty, and being a very religiously-oriented nation with obsolete political traditions, it preserved backward ideologies mixed with progressive ideas, etc.

In all similar cases the accumulation of internal instability sooner or later leads to a crisis.

This crisis can take different forms, depending on the structure of the society and the sum of external circumstances. In patriarchal or feudal organizations with natural economies it is expressed in the form, for example, of "overpopulation". Prosperity leads to excessive reproduction, which puts an end to it. In capitalist organization crisis takes the form of "overproduction": the influx of substance and energy from industry fails to be assimilated by society due to the disbalance of its interrelationships, and it is spent spontaneously and fruitlessly or even harmfully to the society. Finally, in some cases, and for any type of social systems, the crisis made ready by internal processes, though not to the degree where it can manifest itself independently, is called forth by external influences. Derangement of the organizational harmony of a society leads to military weakening, the inability to exert sufficient resistance to an attacking enemy. Military organization, which concentrates a great deal of specific resistances proves, in these cases, to be deeply "confused" and "disordered". For this, good illustrations are the defeat or even disappearance of many Ancient societies, "coddled" by many centuries of prosperity, the defeat of France in 1870, etc. Of course, by no means can every military defeat be explained by this scheme, only those that were been called forth by periods of lengthy prosperity; and historians, who are normally far from being adherents of tektological ideas, have repeatedly noted this relationship.

The greatest Ancient society, the Roman Empire, was defeated by much lesser military forces than those over which it had gained many victories. And many historians agree that the reason for this was its internal de-organization, resulting from the parasitic degeneration of the free classes, of which, as a matter of fact, this

Ancient society consisted; the slaves could not reasonably be included in it, for they were merely *instrumenta vocalia*, the speaking instruments of society. The parasitic degeneration of a society is the result of a lengthy prevalence of the assimilation of energy over *decreased expenditures*, which is, for society, the most adverse case of positive selection.

But if we were to look at the slaves as members of society, considering them, from the contemporary point of view, as a productive social class, we would clearly discern the growing inhomogeneity of the elements of society caused by positive selection. In this case, the influx of excess energy from the sphere of production was distributed so unevenly, that, even in the early stages, it was completely appropriated by the free classes, while the slaves could hardly keep body and soul together, and were left with no potential for development. And as this influx reduced, the superior classes set to compensate for it by making use of the vital energy of the slaves, whose expenditures by this time already exceeded their assimilation, so that they were subject to a lengthy negative selection resulting in their final extinction.

As is well known, the crisis of military impotence was an outward expression of a profound and protracted economic crisis, which started immediately after the culminate moment of its prosperity and which devastated the Roman Empire.

The crises caused by positive selection — though we should remember that they are not the sole type of crises — are usually followed by a change in the direction of selection; it becomes negative. It is especially evident, and the functions of negative selection are especially clear, in regard to social systems. It is manifested in the destruction of those elements, relationships and groupings, which are less stable and viable, and which disturb the

internal harmony of the whole to a greater degree. The system is simplified and becomes more harmonious. Therefore, if negative selection, failing to destroy the system completely or, at least, significantly, is substituted by positive selection, the subsequent growth and development of the system becomes more organized; the viability of the society grows similarly to that of an organism, as is the case in those situations I have indicated.

For instance, the economic crisis of overproduction destroys a set of weaker or less expediently organized enterprises; for other enterprises, it means a cut-back in production, along with the elimination of less productive waste, the reinforcement of internal economy, the dismissal of less able organizers — managers and engineers and the repudiation of nepotism, which can easily grow to a huge extent during years of prosperity, etc. Everywhere crisis tends to the discarding of obsolete modes of production and forms of organization in favour of the newly available manners and forms. As a result, when the crisis is over and again replaced by positive selection, the economic systems can become — as they did in the past — peculiarly sanitized and, in spite of the sharp temporary slackening, capable of achieving new prosperity based on a higher level of technology and organization.

But this example also clearly shows that the greater the extent to which this operation of negative selection is essentially spontaneous, the more inconsistently, imperfectly, and incompletely it performs its progressive function. Along with non-viable, obsolete or moribund elements, relationships and groupings, it destroys many others, which are useful and important for the development of the social system, actively productive elements, whose progressiveness is irrevocably manifested by the subsequent course of the social process. It would suffice to mention only the waste of labour forces and lives caused by unemployment during economic crises. And of

the enterprises destroyed by crises, far from all belong to the number of the weaker or poorly organized: general downturn carries away with it a lot of advanced enterprises.

This manifests the *relativity* of any notion of viability, or dynamic stability. Usually, when we speak about it, we mean the standard or average conditions of the environment of given complexes. But this is only a general, standard level of viability, or stability, rather than its specific value. The latter depends on specific, particular conditions, and varies in correspondence to them. Negative selection destroys everything which is non-viable or unstable under the *given* conditions. Any developed complex, particularly society, implies some diversity, a certain inhomogeneity of conditions. Therefore, elements or groupings, generally or "standardly" more viable, or stable, or better organized, under less favourable and sometimes extreme conditions can die, while other, less organized elements or groupings can survive and become stronger under especially favourable conditions.

There is no special need to elucidate or prove the same conclusions in regard to crises which are manifested in the military defeat of a society. Incidents, when defeats served as the starting point for national renewal are well known, but far more frequent are those cases, where defeats led only to a huge waste of forces and the lingering decline of a society. The simplification of its internal relationships and correlations, imposed by the law of negative selection, often results in the degeneration of a society, or its transition to a lower level of development.

Lengthy periods of overpopulation were equally spontaneous engines of progress in less mobile tribal and feudal societies. For them, negative selection with its prolonged disruption of social relationships along their weaker points and axes sometimes led to the

rupture of their social organization — to the split of a tribal or feudal community into two which begin to live independently — not unlike the split of a mother-cell into two daughter-cells. Sometimes, there was a break between the community and its territorial environment, which did not provide it with a sufficient influx of energy: and re-settled in other places. Generally, it caused the weakening and shattering of all the traditional forms and relationships of community life, making possible the growth of the available germs of newer technological methods, production relationships and progressive ideas. In contrast, a situation of equilibrium or positive selection gave no opportunity for the conservative structure of such organizations to develop in this way.

So, similar basic traits can be discerned all along the line of the experience of progressive selection available to us. Comparing the functions of positive and negative selection in world development, we can say that they embrace its whole dynamics. Positive selection, by making forms more complex and the being more inhomogeneous, provides it with a greater amount of materials. Negative selection, by simplification of these materials and the elimination of everything which is unstable, non-harmonious, contradictory, by making them more homogeneous and well-coordinated, creates order and systematizes them. Being complementary, both processes spontaneously organize the world.

Mankind has always been attracted by these schemes in its scientific, philosophical and, earlier, in its religious thought. We can elicit them in their most universal, tektological form from science; in philosophy we also find their germs everywhere and especially in Hegel's dialectics. In religion they were embodied in creative and destructive deities. Folk tektology did not confine itself to the evaluation of positive and negative selection as "well-being" and "disaster": it knew both the slackening potentialities of the former

and the organizationally reinforcing powers of the latter; and it is not without reason that in the field of child rearing it favoured "strengthening" severity over "effeminating" softness.

**§ 2. The Law of Relative Resistances  
(The Law of the Least)**

The summary stability of a system in regard to its particular environment is, obviously, a result of the *partial* stabilities of the different parts of that complex in regard to the impacts upon them. Therefore, we need to find out precisely what the relationships between the stability of its separate parts and that of the integral whole, which is comprised of them, are.

Let us suppose that we have a chain composed of unequally strong links. On this chain, loads of different weights are suspended. The majority of its links are capable of bearing a load up to 1000 kg without being torn apart, some of them — up to 1500 kg, and one link — only up to 500 kg. The question is: what is the maximum load, which the chain as a whole can bear? Certainly, it is only 500 kg, for if given the load is more than that, the chain will be broken at its weakest link. The structural stability of the whole is determined by its *lowest* partial stability. This scheme applies not only to mechanical systems, but resolutely to all kinds: physical, mental, social. If an organization of people, e.g. an Army, has to overcome destructive impacts, then its stability also depends on the least of its partial stabilities; and the logical chains of arguments are broken when one of their links cannot resist the blows of criticism.

But in practice systems are not usually exposed to equal and uniform impacts against all their different parts. Even in our example of the chain, its upper links must resist, along with the suspended load, the

weight of all the lower links, a factor which sometimes can be decisive; the front line of an Army is subject to attacks of unequal strength at different points and at different moments of time, etc. Therefore, we should introduce the concept of *relative resistance*. The mechanism called the complex block contains several ropes, of which one should bear the weight of, say, 1.000 kg, while the second one — of only 500 kg, the third — 250 kg, the fourth — 125 kg, etc. If the first of them is capable of resisting a weight of 1500 kg, then its relative resistance will be  $\frac{1500}{1000}$ , or 1.5; if for the second the extreme tolerance is 600, then its relative resistance is 1.2; if for the third it is only 250, its relative resistance is 1; the action of this weight on its coupling particles will lead to their full disingression, and, as we know, the rope will be torn. All the more so if the relative resistance of one of its parts is less than one.

If the intensity of the external impacts or the structural state of the system vary, then it is sufficient for the relative resistance in any one of its parts, and at any very brief moment of time, to become less than one, and the system will be destroyed; of course, the scale and significance of this process will depend on the whole sum of organizational conditions. A giant, who falls asleep for a moment, can be killed by a feeble dwarf. It is sufficient for the epidermis of the surface of the human body to be hurt by an injury of 0.1 of a millimetre in length and width, which is less than  $10^{-8}$  of its area, and for harmful microbes to have access to this injury for only a second, and the organism is infected, perhaps fatally.

*The stability of the whole depends on the least relative resistance of all of its parts at any moment of time.* This law is of great vital and scientific importance. In this form, the statement embraces all organizational and de-organizational experience pertaining to ingressive complexes. In any struggle, it is the principle of both attack and defence — in war, in ordinary fight, in fencing, a chess



game, hunting, etc. Frequently, a whole sequence of the most complex wiles, which might be absolutely incomprehensible to the uninitiated, is constructed to ensure that the relative resistance in some point and at some premeditated moment of time will be less than one (i.e. less than the activity with which it is confronted). On the contrary, the tactics of defence strive, and often also with very sophisticated means, to ensure that the relative resistance in any threatened point at any moment of time will be no less than one.

Illness is the struggle of an organism against some de-organizing influence; therefore, many correlations which are typical for the art of war are reproduced here. For example, coldness produces a harmful influence on the whole organism; its action extends over the whole surface of the body; but the destructive effects start from the less protected parts of the body: from those which aren't clothed, like the face, and those with poorer blood circulation, like the feet; the ears get frost-bitten most easily, because they usually combine both conditions of low resistance.

Syphilis is an illness caused by a kind of bacteria, pale spirochetes. They, as well as the majority of other harmful bacteria, penetrate into the organism after the violation of the integrity of the skin's epithelial tissues. Let this surface be normal and impenetrable for all but  $10^{-8}$  of its area; if the agent of the disease has access to this point, the whole protective function of the skin is reduced to nil, or to put it more exactly, to the activity exerted at this very point. After that, when spirochetes penetrate into the blood and start to reproduce in it, all the parts of the organism which are washed by the blood become subject to their "poignancy" (that is, their intense reproduction which is destructive to the tissues); and then morbid processes show up here and there — wherever the resistance to this "poignancy" at a given moment is reduced. This is the cause of the vast multiplicity of the manifestations of this disease.

By the way, the grave notion of "responsibility" in organizational (technical, political and any other) practice also is based on this law. In order to sustain the sufficient stability of an organization through timely expert interference, its leader may do what he does in a proper and expedient manner for many years; but let in one issue his intellectual energy leave him, or just for one moment his attention be distracted — and irretrievable harm is frequently produced, which sometimes, as in battle, leads to complete breakdown<sup>1</sup>.

It should be noted that the concepts of "activeness", "influence", or "resistance" are fully tektologically correlative and can be substituted for each other when the point of view, the starting point of analysis, is shifted from the complex to its environment. Hence, the scheme of the "least relative resistances" of the different parts of the complex is equivalent to the scheme of the "least relative activeness" of these parts, or the "extreme relative influences" of the environment, or its "extreme relative resistances"; and the latter formula covers many cases which apparently cannot be subdued under the former.

Suppose, there is a squadron comprised of vessels with different velocities, drafts and capacities of coal holds. The maximum velocity of battleships is, say, 30 km/h, of cruisers — 40 km/h, of destroyers — 50 km/h. What is the maximum velocity of the whole squadron over a long navigation? The velocity of a ship is the measure of the water resistances which it overcomes, or the measure of the complex's own activities; the least relative value of these activities is the same as the maximum relative value of the confronting resistances and, certainly, they are manifested by the lowest maximum velocity — 30 km/h. Indeed, the velocity of the whole squadron will necessarily be this — the maximum where it is still able to preserve its integrity and unity of actions; those vessels

which, over a sufficiently long time, develop higher speeds, will lose touch with the battleships, and the squadron will disintegrate...

Furthermore, let the submerged part of the battleships be 10 meters, of the cruisers — 8 meters, and of the destroyers — 5 meters. If the squadron is to go through the comparatively shallow waters of some channel what is the most shallow waterway it can pass through? Here the most convenient way of speaking is about the resistances of the environment; clearly, they correspond to the maximum draft, i.e. 10 meters; where battleships can pass through, other ships can do the same, but not the other way around<sup>2</sup>.

Similarly, if some vessels have in their holds coal sufficient for 10 days of navigation, some — for 15 days, and some — for 20 days, then the maximum distance of their navigation from one coal store to another can not exceed a 10 day voyage, etc.

It should be noted that the tektological concept of "part" is much broader than the common understanding of this word. Suppose, for example, that a body with a certain form must be dragged through a hole whose walls are impenetrable to actual activities: a piece of furniture through a door or a prisoner through sawn bars. Here we must pay attention to the "maximum relative resistances of environment"; and they are most significant to the largest cross sections of the body, or even more precisely — for the greatest measurement of each cross section. Therefore, a body will pass through only if no measurement of its cross sections exceeds the corresponding measurement of the hole, otherwise for this measurement the relative resistance of environment will be more than one, i.e. insurmountable. Cross sections, or "areas", and even their measurements, or "lines", are, tektologically, parts of the complex, or body<sup>3</sup>.

Frequently we have to consider the relative activities-resistances of a complex and its environment as changing over time, to examine the complex-process. All the moments of this process represent the links of one temporal chain, and these links as parts of the whole should be considered from the same point of view. For instance, suppose we have a confined territory and the question is raised regarding its capacity to support a population: how many people — of course, under a given level of technological development — can live there? The answer is: as many as can sustain themselves in the most unfavourable years, the years of the poorest harvest, etc., i.e. in the years of maximum relative resistance to the environment.

If the product of a workshop passes through the hands of several workers or a business visitor to a bureaucratic institution has to pass through several officials, the number of ready products or number of satisfied visitors depend on the worker or officer, who performs the least number of corresponding operations per hour. It is sufficient that only one out of ten possesses an abnormally low working capacity for the working power of the remaining 9 to be, to a certain degree, paralyzed.

Modern language has not yet been purposefully adapted to the precise expression of organizational relationships and regularities; ideas of activities-resistances are often vague and unclear; as the illustrations given above demonstrate, sometimes a special effort is needed to comprehend what, precisely, in this or that case, should be considered as a manifestation of a complex's activities — what as a representation of its influences or resistances, and into what parts should it be decomposed for analysis. As a first approximation, it is more convenient to take this law in a somewhat different, less strict verbal formulation: as the law of the *least favourable conditions*, or, more briefly, as the law of the *leasts*. It implies that in the least

favourable conditions, the lowest positive values should be considered in regard to the complex which is under study.

This form of expression is especially expedient in the field of social-organizational practice — the economic, political or cultural.

Suppose, for instance, that there is a party of the "block" type, two factions of which are constituted by two social groups or classes — one being progressive and the other backward. Which of them will in fact define the party program and tactics? In accordance with the scheme of the least favourable conditions — the backward one. This is an unusual and even unexpected conclusion, perhaps because the advanced class or group to a great extent "leads" the backward one, generally it puts forward slogans, nominates leaders, etc. Yes, but the actual limit to the effectiveness of slogans and leadership is determined by what the backward part of the whole can agree with; any efforts made to go further cause the links of the block to be consecutively severed, as during a campaign, the links of a detachment, comprised of infantry and cavalry would break, if the cavalry did not limit itself to the speed of the infantry.

The principle of relative resistances as it is represents nothing new for science: in mechanics, physics and the technical sciences it was formulated long ago and is applied with great precision<sup>4</sup>. But each science has had to discover it independently. For instance, in agronomy it was discovered only in the last century by J. Lybykh, who called it the "minimum law". This is the main principle of crop yield in agronomy. Plant growth requires a whole number of measurable conditions: the energy of light, warmth, water, carbonic acids, oxygen, salts of potassium, magnesium, ferrum, nitrous and phosphoric compounds, etc. Liebig established that crop yield is determined by that one of these conditions which is available in the relatively least amount. For instance, if conditions are pertaining

sufficient to produce 100 poods of crop from a desiatine, but nitrogen in the soil is scarce — there is enough of it only for 10 poods — the crop yield will be 10 poods.

One German scientist has invented an instrument for the demonstration of Liebig's law: a tub, whose walls are made of boards of different lengths; each one corresponding to a relative value of a condition of crop yield; the tub is then filled with water to its maximum: this being the measure of the yield; this maximum is determined by the shortest board, where the surplus water overflows. Clearly, this is a tektological, rather than solely agronomic instrument, it demonstrates the law of the least in general form (I borrowed this description of the instrument from K.A. Timiriachev<sup>5</sup>). Tektology for the first time makes this law universal. By extending it into all kinds of complexes, through to psychological and logical ones, it shows how this law can be applied to new and more complex phenomena. From its initial steps it is a consciously practical science.

### **§ 3. The Law of the Least and the Resolution of Practical Problems**

Like any other scientific law, the law of relative resistances can express either the domination of nature over people, or the rule of people over nature. A building will collapse if an unskilful architect fails to adjust the strength of the beams to the maximum pressure that will be put on them; a dam, which protects fields and houses from floods, will, with the passage, of time inevitably and disastrously breach, if the maximum possible increase in the level of water along with the most unfavourable combination of the strength of the current and wind are not taken into account; an enterprise will not survive if its organization is not ready for unfavourable

market conditions, etc. The all too well known trinity of Russian national tektology — "maybe, perhaps and somehow" — expresses nothing other than the ignoring of the law of relative resistances, resulting from the insufficiency and incoherence of organized experience — caused by what is often called the "low cultural level". On the contrary, by expedient and systematic application of the law of relative resistances, people would be able to achieve the maximum stability of their organizations, their technical and ideological constructions, and protect themselves against the eternal threat of the elemental forces.

The problems, for whose resolution this law should be consciously applied in a systematic manner, are numerous and infinitely diverse. It generalizes a vast number of important methods, which have existed in science and practice for a long time, but only in their particular and isolated forms, and which are, hence, only partially applicable — in this or that area of labour-experience; beyond these boundaries they are usually either ignored or assimilated with greater effort, uneconomically in the sense of mental energy, owing to their non-systematic and non-universal character.

In general, all problems of this nature can be subdivided into two types. The first deals with those where there is a need to overcome *finitely-varying* influences or resistances, the second — where the values to be overcome are *infinitely-varying*. Examples of the first type are any kind of building, machine or instrument: their different parts are subject to pressures, friction, blows etc. of various intensity; however, with the help of experience and theoretical calculations these variations can be expressed in certain ratios. Examples of the second type are: a child, who is prepared by his/her upbringing to work and struggle in an infinitely changing, unpredictable world; an Army in defensive order on a temporarily established front-line with no objective information about the

enemy's tactics; a piece of art or science presented to an audience little-known to the author, etc. Problems of these two types are resolved using two different general methods.

The principal solution of the first type is quite obvious. If it is known that a given complex or system in some of its parts must endure influences or overcome counter-actions of some type and degree, then these parts should concentrate activities-resistances of a corresponding nature and in proper amounts. The difficulty here is in *knowing the kind* and amount of the activities which should be overcome, and to *dispose* sufficient activities against them. The first task is achieved through the collective *experience* accumulated by science, and the second — by collective *labour* which provides technical domination over the elemental energies of nature and the possibility of utilizing them.

Regular industrial technology is always based on the idea that the newly organized complex — "product" — within an observable period of time is inevitably exposed to various destructive influences. If it is, for example, an instrument — an axe or a hammer — then by its very purpose it must undergo de-forming, de-organizing influences from the material it is intended to process: besides, it might rust and spoil from humidity, air, etc. If the case is of a bridge, it will suffer, firstly, from the pressures and stresses, caused by transported loads, secondly, from destructive storms, floods, and then from chemical atmospheric influences, etc. All these hostile activities must be met by a sufficient resistance on the part of the product; and for every part which is indispensable to the integral system, the relative value of this resistance must always be more than one. This, as we see it, is the point of "defence". It determines both the preliminary calculations and the actual performance, which create the product.



At the points of maximum destructive influence maximum resistances are also concentrated. Then, by various means, these influences can be reduced, especially when they are not directly related to the purpose of the product. Particularly, the method of indirect reduction by qualitative substitution of resistances is often applied. For example, a building, however well it is built, cannot exert sufficient relative resistance to the tremendous power of lightning. But the electrical voltage of a cloud can be reduced by using a lightning conductor, and the impact of the lightning can be drawn aside, where it cannot produce any practically important damage. Similarly, in military defence by manoeuvring, the enemy's fire is drawn to the points of the utmost resistance or where it will cause less damage.

The principle of the least relative resistance determines, in the same measure, the fate of human organizations, their preservation, partial or complete destruction under the impacts of such different, complex, and variable influences as occur in the social environment. As people themselves deliberately create their organizations, they always paid, and still pay, regard to this principle by applying it in the form of various "tests", "studies" or "examinations". The nature of these devices is such that the elements of organization are *selected*, that the most expected influences of a hostile environment are met by them with a relative resistance which will be no less than one. This selection is sometimes made so that the elements to be organized are directly put into conditions similar to the maximum expected influences. For example, in the past every apprentice, who wished to join a guild of masters, had to produce a "chef d'oeuvre" of his craft, that is, a product, corresponding to the most difficult tasks, which might be put before the craftsman in his future practice; in old and persecuted secret societies newcomers had to undergo cruel tests almost equal to the tortures they would suffer from their enemies in the case of capture.

These applications of the "testing" method are especially illustrative of the claim that the concepts of "activeness" and "resistance" are tectologically fully correlative and can always exchange places. While the conspirator in the torture-chamber is indeed suffering under an external influence, the shoemaker is apparently only overcoming resistances. But resistance is the activeness of the object confronted by the activeness of labour. In principle, there is no difference between the testing of a newly constructed bridge by putting the maximum load on it and the case where a candidate engineer is made to make one of the most difficult calculations which he might meet in the future<sup>6</sup>.

In the field of more specialized practice — in the case of the organization of ideas — the lack of proper terminology and even of the simplest measuring devices makes it difficult to illustrate the role of the principle of the least relative resistances. Nevertheless, we can point to the way an author behaves, when he works out some ideological whole — a paper, treatise, plan or any other "composition" (i.e. in accordance with the exact meaning of the word — "something co-ordinated", organized). Hostile, de-organizing influences are perceived by the author in the form of "criticism", "polemics", sometimes "censure". He scrutinizes every chapter, every paragraph, every phrase of the composition from the point of view of the blows they may receive, he reinforces weak points with additional arguments, expurgates, as far as possible, controversial or dubious passages in order to reduce the "vulnerable surface", outlines new relationships between the facts he mentions to strengthen the general resistance of the system, dresses the ideas threatened with censure in a protective suit... These calculations of "relative resistances" are most apparent when the work is made not by one, but by several authors, in the communication of many people, rather than in the head of single individual, for instance,

when a party Congress works out its Manifesto, when Committees draw up draft resolutions, etc.

It is well known that old organizations strove to raise to the maximum the resistance of their members to the various, and dangerous to the whole, stimuli by means of dreadful vows and oaths, as well as by less naive methods, that is, the cruel punishment of those who could not overcome the counter-organizational motives of their psyche. In spite of very dissimilar manifestations of the methods, their scheme for the reinforcement of the relatively weak and most threatened points with special barriers does not differ from, for instance, the armouring of a battle-ship, the shoeing of horses, etc. — the scheme of "additional resistances".

The principle of the art of war and generally of expediency in any struggle consists in directing de-organizing efforts towards the point of the least resistance. Let us take the case of a city under siege. Here the chain of resistance is represented by a rather complex system of both technical and social nature: a series of fortifications and their defenders. Sometimes, the information about the weakest and least protected point, obtained from scouts or traitors, sufficed for the rapid success of the attacking troops. More often, the attacking Army had to prepare its assault, trying to reduce the resistance through planned actions at a specially chosen point. This is produced, for instance, by the concentrated fire of ordnance, which makes breaches in the fortifications and kills and demoralizes the defenders of the chosen point. The desired result may also be produced by false assaults to lead the majority of defenders away from the point where the real attack is intended to take place. Similarly, on the field of battle, the lines of lower resistance are sought or created so that by acting on them the enemy's communications are broken, etc.

In the tactics of defence the reduction of destructive impacts is also very broadly applied, for instance, by minimizing the number of accessible points. In the technics of industry and war, for that very purpose, the surface which is exposed to hostile activity is sought to be reduced. For example, in the construction of houses in the regions of the extreme north people avoid corners and use curved forms, which have a minimal area of cooling; in duels, adversaries stand sideways, rather than front on to each other, to achieve the minimum target surface, etc. In the organization of people this tendency takes a multiplicity of other forms; for example, persecuted sects or parties allow meetings of their members strictly within the limits of business necessity, restricted personal communications, correspondence, knowledge by members about the wider organization, etc. The struggle for the freedom of organizations, as well as of organizational methods — of speech, meetings and the press — is the struggle for the reduction of impacts hostile and destructive to the system and its activities.

As to the problems concerning finite resistances, we can generally adopt the view that people can solve them. If the solution turns out to be unsuccessful, as frequently is the case, then the fault is not of the method, but of other points of the matter: it may be imprecise data, on which the plans were built, or calculations which were erroneous due to the imperfection of the nervous and psychic systems of the people who performed them, or new circumstances appeared, which before that had not been observed and therefore could not be taken into account. What the method was deprived of before was the recognition of its universality and, correspondingly, its general formulation.

But even this deficiency is not an unimportant thing. It leads to a situation where people, who skilfully and successfully apply this method for the solution of technical problems, which are simpler

and easier by their nature, do not apply it at all, or apply it unconsciously, and therefore poorly, just where the problems are most complex and difficult, e.g. in the field of social organization, education, in artistic work, etc. Besides, knowledge is acquired non-economically when it is generalized insufficiently: special efforts are needed every time for the mastery of one and the same method in different spheres, for it is perceived as something different and new.

Here is, for example, a rule of the tactics of war: "the one, who assumes the offensive, has the advantage". This is one of innumerable particular applications of the principle of relative resistances. The one, who inflicts the first blow, can choose the place and moment of it, and, obviously, concentrate there his forces. When the first blow is struck, resistance at that point is reduced and, if the offensive is ongoing, its chances, of course, are improved. Those French commanders, when they proposed, in some battle, in a gentlemanly manner that the Englishmen take the first shot, had evidently been wrong not least because the French soldiers killed by these shots could by no means shoot in return.

For those who have comprehended the rule of "offensive" as a particular implication of the universal principle, it is immediately evident that it can be applied to any other struggle — economic, political, ideological. And as experience shows, frequently those who create something new in these spheres and should foresee the inevitability of a struggle for it, begin to understand the full practical significance of the offensive only after they receive a number of blows.

The principle of *concentrated action* in other, outwardly dissimilar but essentially identical, applications dominates all technology. For instance, the reason for the use of sharp instruments is that all the power of an action is there applied to a very small surface, along

which the sum of molecular coupling forces is correspondingly small; for a blunt knife or axe this surface is greater than for a sharp one, and therefore that many times greater is the sum of resistances to be overcome. A blow in this case is more efficient than just pressure, for it concentrates the action into a very brief period of time. Assume that a resistance exceeds by 10 times the activities directed against it, which are disposed during one second. Then it would suffice to apply the same activities over not a second, but one-twentieth of it, and then, as the relative resistance will not be 10 but  $10/20$  — less than one, i.e. we will overcome the resistance, and the planned destruction will occur.

The reason for using explosives is the same. The chemical energy contained in a pound of dynamite is not so enormous as is generally believed, it is not much greater than the energy contained in a pound of coal. But if it is needed, for instance, to tear off and crush a part of a rock, then to break it using, say, a steam engine, we would have to burn maybe hundreds of pounds of coal, while the same result could be achieved by exploding one pound of dynamite. The energy of coal burning is distributed into a set of individual acts and over a relatively long period of time, while all the chemical activity of dynamite is spent during an infinitesimal portion of a second in one avalancheous action; during this period the chemical bonds of the mountain rock are broken and cannot be renewed. But if we were to concentrate the energy of the burning of coal into one similarly brief act, it would manifest the same awesome properties: this happens when a steam-boiler explodes.

It is easy to see how important the rule of concentrated action is for any ideological or cultural work, for instance, education, political agitation and propaganda, the work of the artist, etc. But the majority of workers in these spheres come to an understanding of this and its systematic application separately and independently of

each other, by means of their own particular experience, and at the cost of a number of errors and failures. The inexperienced lecturer or propagandist tells his audience everything they should know usually in the most comprehensive way, trying not to miss anything; and their perceptual activities are dispersed in many directions, so nothing is firmly acquired, and the productivity of the efforts of both sides is minimal. The old rule *non multa, sed multum* — not much, but profoundly — is here a suitable formulation of the principle of concentrated action, and the positive, progressive aspect of scientific specialization is indebted to the same tektological feature<sup>7</sup>: the concentration of activities within a limited sphere of applications in the cognitive struggle with nature.

Problems belonging to the second type appear where the environment, its impacts and resistances, are changing indefinitely and cannot be taken into account in advance in relation to their inhomogeneity. Certainly, a problem may be just insoluble — precisely, when the indefinite changes of the environment do not occur within certain limits sufficiently commensurable with the actual means of solution, i.e. the summary stock of appropriate activities-resistances. For instance, the task of the protection of ant-hills from attack by external enemies is, in general, insoluble for ants, when there are such beings as people, but it is soluble in relation to other ants and insects. People are able collectively to build fortresses, which satisfactorily protect them from any living enemies, but they still cannot shield themselves against geological and, even more so, cosmic crises. So we should inquire into a problem, obviously, within the limits of its relative solubility.

If any part of a system can be subjected to unpredictable forces, then it is clear that any inhomogeneity of the concentration of resistances in favour of some of its parts and, consequently, to the detriment of others, is absolutely pointless. At the same time, it is extremely

dangerous, for it creates the probability of a destructive result from even relatively weak impacts, if they are confronted by the flimsiest parts of the system. The maximum relative stability here is achieved by the *uniform distribution of activities-resistances* between all the risk prone links of the whole.

In this general form the problem is resolved spontaneously by nature, and more or less consciously and in a systematic way — in human practice. The shell of a mollusc manifests an approximately uniform protection of its bodily surface from mechanical and other impacts; and the deviations from this uniformity which sometimes happen are explained by the need to resolve other special tasks; for the vital tasks of an organism must be resolved all at once, and these solutions, naturally, partially constrain each other. Similarly, the threatened surface of, say, a fortress is made by its builders to be protected in a uniform way, with no weak points, insofar as it is possible with regard to the other vital conditions of the system; for instance, when cities were fortified by walls, it was still necessary to make gates in them for dealings with the external world; but the forced slackening of the protective shell in these points was compensated for by a reinforcement of the guard, etc. The same is true for temporal organizational relationships as well: if the chances of an offensive cannot be taken into account in advance — even in the case of a group of researchers travelling through an unknown country populated by savage tribes — then it is necessary to keep a permanent and uniform guard; its slackening even for a short period of time could prove to be fatal, and its reinforcement for no sufficient reason would mean a fruitless waste of energy, whose conservation is so important under the circumstances. When an account of the possibilities of food provision becomes impossible for an indefinite period, all members of the collective are supplied with a uniform minimal ration, etc.



It is obvious that problems of this kind generally appear when the actual system already has a certain uneven distribution of activities-resistances between its parts or links, which is harmful for its stability in an indefinitely-changing environment. Typically, this situation occurs very frequently when a system, which developed in some environment with its heterogeneous, special correlations is transported into another, where the correlations are different. For instance, an educated European, who has grown up in a city and occupied a certain social rank, in correspondence to which his "abilities", that is, the distribution of the activities of his organism, were developed, is transported into the virgin steppes or primeval forests. There, among innumerable and unknown opportunities and threats, his special knowledge, say, of the textile industry, mathematics, literature or management turns out to be not only useless to him, but a great deal more: being achieved by the concentration of activities on the definite functions of certain organs, and based on the reduction of the energy for other functions, other organs; it is the result of a major non-uniformity of development, which was possible and convenient in a cultured social environment, but can be fatal in the lap of spontaneous nature, where the cultural and technological apparatus of society does not protect him from its blind activities anymore. The task here manifests itself in the form of the necessity of the strenuous work of different organs; and the activities of the organism should now be re-distributed from exorbitantly to less developed functions. With the passing of time, as he succeeds in coping with the situation, even this environment ceases to be indefinitely changing and turns more and more into a definitely changing form: he has only to build a hut and the indefinite variability of temperature and humidity will be removed; the cultivation of a plot of land will make more definite the conditions of his nourishment, etc. The organizational task of his life is also changing its character, being step by step transformed

into that of the first of the types examined above. This shows that there are many intermediate stages between these two types; or, to put it more precisely, they are constantly combined: in some aspects, in the manifestations of some groups of activities the environment appears as definitely changing, and in other aspects — as indefinitely changing.

Consider two opposed Armies. The one which takes the initiative and assumes the offensive has to resolve the task against a definitely changing resistance. So the region of the offensive should, naturally, become the region of the utmost counteraction; the curving of the front-line itself increases the surface of contact between the attacking regiments and the enemy; besides, these regiments must leave their shelters, thus increasing the relative power of adversarial action; and the enemy, of course, will deliver all available regiments to the region of the offensive. Consequently, the first Army should concentrate a sufficient amount of its troops in this area, and in other areas — sustain that amount of them, which might be needed to resist any possible counter-manoevres intended to undo the effects of the breakthrough, etc. If everything is well calculated and the relative resistance in desirable points was less than one, then the task is fulfilled, and the enemy is partially or completely defeated.

If the enemy is only driven back and keeps his positions firmly with relative resistances equal to one, then the task assumes another form. Here there might be two cases. Either the forces are sufficient for a second thrust, and then a solution of the first type should be organized anew in the altered situation; or the forces are exhausted, reserves are scarce, thus the offensive must be temporarily relinquished, then, if there is still no threat of an offensive from the enemy's side, the task is of the second type, that is, of a uniform consolidation of the front-line, the re-distribution of forces to the benefit of its weakest segments.

These illustrations clearly show that, firstly, the solution of tasks with a definitely changing resistance is tektologically more beneficial and is of more planned character; and secondly, transition to this type from the other may depend not only on the character of the environment, whose impacts would gradually become more and more definite, but also on the active attitude of the system itself towards its environment: by acting on the environment, the system in a way, chooses its resistances.

The upbringing of a child is a very important socio-organizational task. The majority of people, while not being specialists, have in this or that measure something to do with it, but even professional pedagogues cannot claim that their work in general has a firm scientific foundation. Let us see what the fundamental formulation of that task is from the tektological point of view.

Usually, the aim of upbringing is formulated as the "development of the physical and mental faculties of a person". The notion of "faculties" is vague and abstract, but the main thing is that it lacks the idea that the developed activities should be correlative to the external and internal environment of the society, a member of which the person is. So, the very foundations of contemporary upbringing contain much vagueness and therefore a great deal of instinctive traditionalism, which does not conform to the complicated, changeable social conditions of the present time, to the new forms and relations of social and extra-social activenesses. Meanwhile, the principle of relative resistances is inevitably and sometimes grossly violated.

The object of an upbringing is a person; but its factors and tasks lie in the ingressive social whole — society, class or group. The upbringing of a person is nothing other than the partial self-education of the collective. Essentially, this is the process of the

introduction of a new member into the social system. It prepares the individual for his vital function, or rather sum of functions, which are expected of him by the society. These functions, the circumstances of their fulfilment, the resistances they will have to cope with, may partially be foreordained, and partially lie beyond the anticipation of the educators. Therefore, the conditions of the task are dual: the definitely-changing environment, on the one hand, and the indefinitely changing one, on the other. The proportions of these two aspects of the task are different in different historical systems.

Older types of social organization are notable for their conservative way of life; such are the primitive tribal communes and the later authoritarian tribal and then feudal societies; the same feature to a considerable degree was also inherited by the first feudal market formations — different types of slave-owing, serfdom, and even urban craft societies. Everyday conservatism secured the social position and functions of parents for their children: the son of a feudal martial organizer had to become likewise a detachment commander; the son of a serf peasant — likewise a dependent farmer; the son of a blacksmith — a blacksmith. Social role was foreordained to the greatest degree, and correspondingly the task of upbringing was also pre-determined: it developed the activities of a child in similarity to those of the father or mother by domestic or sometimes corporative education. The principles of education were very simple: everything was reduced to imitation or mechanical cramming, and then to particular practical exercises; special educational systems were either rudimentary or entirely absent. While the social situation is stable, this is quite sufficient: life routinely, from one generation to another, reproduces the same technical and socio-organizational activities by means of which the same resistances of elemental or human nature are surmounted. But when an individual falls into an unforeseen situation he becomes, in

the vast majority of cases, powerless and helpless. And if what is changing is the overall natural or social situation, the whole life of the conservative collective turns out to be maladjusted. So, the forced resettlement of savage and barbarian tribes usually led to the extinction of a significant part of them — at least, in the initial stages. And the extinction of under-developed populations after even the most peaceful contact with civilized nations is even more remarkable, and sometimes it is not easy to grasp its direct causes. But there is one general cause: conservatively developed organisms are stable only in conservative environments; when the environment becomes variable, then inevitably in some parts and some functions of these organisms the relative resistances must sometimes fall below one.

The substitution of conservative social structures by those having a potential for progressive development based on contradictions — of authoritarian systems by capitalist market systems — radically changes the conditions and tasks of education. The tendency toward the conservation of the social position and role of the parents for their children becomes more and more confined and is very frequently actually paralyzed by the spontaneous forces of social life; and even when it is really manifested, children have to fulfil their functions in a changed and still changing social situation, that is, to cope with resistances of another value and partially of another nature; routine education imitating past experience becomes then insufficient. Consequently, the task of education in a larger part should inevitably be resolved on the expectation of indefinitely changing conditions.

But it cannot be entirely reduced to this, the reason being the following. Since a society of contradictory-progressive type lacks integrity and is anarchical, and since a significant part of the relationships of its elements is occupied by struggle and

disingression, an individual can secure his social position and function only on the basis of a certain stable advantage over others. And of course, this advantage can be gained only by means of the resolution of a task with definitely-changing resistances. Therefore, this faculty also should be developed by education. But in what way?

One of the illustrations we have adduced before has shown that a transition from the first, tektologically less beneficial, type of tasks to the second depends not only on the environment, but also on the active attitude towards it of the complex which it confronts, in our case — a man: he can *choose* its resistances, although, apparently, only to a certain extent, on a limited scale. This choice is foreordained by education in the form of *specialization*.

Indeed, specialization in certain work, with its special materials and instruments, predetermines both the character and amount of the resistances the man will have to deal with, it allows him to commensurate most precisely and definitely the waste of his activities in relation to the counter-action of the objects of his labour and to achieve calculated outcomes in a systematic way. This is most apparent in the technology of the organization of things; but the specializing aspect of education is no less important to the organization of people and ideas. By unfolding increasing amounts of energy in the struggle against his chosen, and ever more accessible to calculation, resistances, a human specialist improves his results, and it is this which constitutes his fundamental and stable advantage over others, which helps him to secure his social role and position. A blacksmith in his labour area deals with the definitely-changing resistances of metals, fire, etc.; in this he outdoes other people: the latter, as they are confronted with similar resistances, for instance, when they use metal things which break, bend, spoil and thus to some degree fail to meet expectation, have to consider them as indefinitely-changing complexes. But the sailor has a similar

advantage in resolving another group of tasks relating to the medium of water, which for the blacksmith and other people are indefinitely-changing.

But this is not the only aspect of the educational problem: beyond his speciality, in the rest of his social and natural environment, a man will still have to take into consideration general tasks with indefinitely-changing conditions. This corresponds to another educational aspect, one which strives to develop organs and functions "in general", irrespective of the special situations and particular goals which have been set in advance. This includes the major part of what is called "physical training" and "general education".

Of course, physical training existed in conservative systems; but if it did not pertain to any predetermined social function of man, for instance, the strengthening of the muscles of a future warrior and inuring his body to bad weather and field discomforts, it was not regarded as an educational task: it was done spontaneously, "in isolation", in childish games and labour, in family and inter-family life. But a society of the newer, contradictory-progressive type is forced to put forward this aspect of social education ever more consciously as a special and important goal, exactly because "by itself" it is achieved ever more poorly with the growth of social differentiation and its inevitable outcome — the narrowing of the educational environment. Suffice to remember to what extent the spontaneously-educating influence of nature is excluded from the lives of urban children, even of the upper classes, to what extent their physical health suffers from merely the miasma and dusty air of the major modern urban centres, how one-sided the bodily development of the children and teenagers, who work in factories, etc. is. And those disorderly developed organisms, weakened in many parts and functions, are confronted by the indefinite

fluctuations of the environment: from the habitual conditions of a workshop to the intricate combinations of modern warfare — overland, marine, and aerial! The problem of the uniform strengthening and adaptation of these organisms to the most diverse conditions has been put before social pedagogy by life itself, and for a long time already life has worked out hygienic, sporting and other methods for its solution.

Equally important is the issue of "general education", i.e. the preparation of the nervous and psychic system for possibilities which cannot be defined in advance. For instance, a man who was born, lived and grew up in a capital city, where the resistances to spatial and temporal orientation are minimized to an infinitesimal value by street pointers, the numbering of houses, electric clocks, etc. Now imagine that, in wartime, he has to steal with his detachment through unfamiliar places, forests and swamps, among threats from people and the elements; must determine the direction of his movement by means of a pocket compass and map, and if they aren't available — by the Sun and stars, which also serve for the determination of the time of day; without some knowledge of geography he and his companions would be doomed to death. Or, for instance, from his tranquil, drowsy provincial life he is thrown into the social hurricane of the revolutionary age with its suddenly changing floods of destructive activeness; what has he to do to hold out, in what direction has he to apply his efforts, when they have lost their habitual objects? He is fortunate if he can rely on a sufficiently profound knowledge of history and the social sciences. These are illustrations of rather extreme situations; but on a lesser scale similar things appear at every step; and even these extreme situations occur in the lives of the majority of people at least once, and to die once would suffice anyone.



The development of the pedagogical task doesn't end here, with its dual formulation implied by the principle of relative resistances; but in order to comprehend the next level, we should make another step in the study of tektological regularities. But now let us dwell on the extent to which the actual solution of these problems by a society which has not yet recognized them as organizational problems is achieved, at its pedagogy, which only vaguely takes into consideration tektological experience.

First of all, there is a permanent tardiness of educational materials and methods with respect to the changing circumstances of social life. For instance, long after the downfall of the authoritarian conservative foundations of economic life, the petty-bourgeois family and even their schools continue to rear children in the spirit of severe authoritarian discipline, which kills incentive and critical ability. Meanwhile, education in such manner, which befitted a society where man had, all his life, to follow ways predetermined by other people, is very harmful in the world of the anarchic struggle of everyone against all, with its changing directions and combinations of human forces, where there is need to make, time and again, an objective re-evaluation of circumstances and to act independently, losing no time. Life demands the permanent resolution of new tasks of the second type, but this training provides a means only for resolving the obsolete tasks of the first type<sup>8</sup>.

Another illustration is the long, persistent conservation of Ancient languages in secondary and higher bourgeois schools. The goal of both of them is, in different degrees, the preparation of the organizers of social practice. In a certain age classicism was a partial but important aspect of the task of organizing as a specialization, since it laid within a framework of determinacy. Latin was the language of international communication, it generalized collective experience, "scientific" experience, as it is called, which is

predominantly organizational experience. The development of new market and commercial capitalist social relations, time and again put the organizing classes — both the old and those which were to replace them — in new situations, facing new contradictions and difficulties. To overcome them successfully, one had to lean on the entire social experience of the past — and here Greek and Roman antiquity played the major role — likewise in the present, the scientific acquisitions of which are also published in Latin. Therefore, overcoming the huge number of resistances in organizing work depended on the knowledge of Ancient languages. But in the developed bourgeois world these circumstances have disappeared; and the enormous amount of labour wasted in colleges, high schools, lycees, universities etc. on the study of ancient languages ceased to serve as a means of the solution of the actual problems of life; and all this mass of energy has digressed from the line of real resistances which people must confront?

The principle of relative resistances is also frequently violated in the sphere of the teaching of modern languages. Children of the educated classes very often study two or three foreign languages from early childhood — first in the family, and then at school. It takes a truly enormous part of the vacant powers of their psyche. Are there many professions, where the corresponding life resistances occupy an equally great place? Very few of them: diplomats, commercial and fiction translators, partially sailors and some groups of scientists. But parents and teachers do not usually put the question in this way; their concern is not preparation for future real resistances, but merely for a traditional conventional "culture".

The lack of an organizational point of view is also evident in the field of physical training. Even now doing physical exercises and the forms of childish games are very seldom based on the problem of

what real processes of life's struggle these or those practical methods may serve; and their choice in this sense often happens to be very inexpedient. The "steeling" of a juvenile organism — this seems to be a case of the most deliberate application of the principle of relative resistances... Some parents who consider it necessary to make their children resistant to cold, dress them in cold weather much more lightly than they are dressed themselves. But when, as it is natural to assume, their children grow up and dress as warmly as their parents, what use will there be of their present higher steeling? But it costs something to the organism by diverting a significant amount of blood to the skin and causing the hypertrophy of its vessels. Notable is the widely spread European tradition or persistent fashion — of compelling children to walk with naked calves, whereas adults always protect these parts of their body very well.

With the coming of puberty each child has to go through the cruel storms of the psycho-physiological spontaneity of their own organism, which has a profound influence on all their further lives. But even now educators, who take into consideration these processes and care for the preparation of youth for these inevitable shocks, are very rare.

A most interesting illustration of ignoring of the law of relative resistances is to be found in the families of many intellectual idealists: this is education in a spirit of extreme "humanity", an extraordinary mildness and solicitude, the protection of children from all possible sufferings, from all the rudeness and cruelty of life. What will these hothouse plants have to oppose the severe blows of real life? They are in advance almost doomed to death.

As we see, even a single sphere of education can provide us with a great many examples of practical importance of the principle under

our study, of how heavily it dominates people when they do not use it consciously.

Other, no less evident and convincing examples of the practical violation of this principle with even more harmful consequences can be found in the life of social organizations.

The role of spontaneity and planning (or "consciousness") in the development of such organizations can significantly vary. Some of them, such as, for instance, the ancient tribal communities and the majority of their subsequent economic groupings appeared quite spontaneously, and then lived and changed in obedience of the pressures of vaguely recognized and consciously unforeseen objective necessity. Their fate was determined, of course, by the law of the least relative resistances, but only in the sense that it *dominated* it as a law of nature, that is, they were preserved since and while the relative resistances of their parts were more than one; and when, with the growth of de-organizing activities, these resistances fell below the necessary level, they were partially or completely destroyed. They submitted to this law but *did not use* it as an instrument in their activities, did not anticipate and change probable correlations in order to prepare for the future course of events on the basis of foresight.

However, we shouldn't take this in a categorical and unconditional form. Any economic organization implies at least a certain degree of foresight of, and care for, the future. In this case the foresight was purely traditional and pertained only to those recurrent changes of the environment, such as, say, night or winter with their hostile forces, which could be taken care of in advance, etc. New and unusual changes of the environment, both external and social, implied, for instance, by the very process of social development,

were unyielding to calculation and spontaneously dominated the fate of these collectives.

But organizations of a higher type have also existed for a long time already. A modern capitalist enterprise is organized consciously and in a planned manner; the correlations of labour activities and technical resistances are calculated scientifically and with great precision; insofar as this is possible with the present social structure and the present level of its understanding, the relative resistances of the enterprise to the impacts of its social environment (probable market situation, probable intensification of class struggle, etc.) are also taken into consideration. A similar, but lesser degree of conscious planning is represented by the modern political parties, culture unions, etc. We will dwell a little on the conditions of the life and work of contemporary political parties.

The social environment they deal with is constantly changing, making changes in all the correlations of their activities and resistances; this is the main feature of the capitalist society called forth by rapid technological progress and incessant internal struggle. All parties in their activities should necessarily proceed from this point, taking this or that attitude towards the changes in correspondence with their own tasks. Foresight of changing external impacts and preparation for them are, here, not just issues of success, but of their very existence.

For this, the principle of relative resistances is the most important tectological instrument; a party which is guided by it in its accounts should expediently distribute its actual forces: to intensify work in some directions, to diminish it in others, to strengthen some points, and, to make this possible, to weaken others. When the resistance of the environment is decreased or is expected to decrease in the foreseeable future, it is necessary to adopt or prepare offensive

tactics (attacks on the enemies of the organization, the conquest of new positions or forces for it). Where the correlation is observed or expected to be the reverse, it is necessary to strengthen defences so that the growth of hostile activenesses does not lead to a partial or complete de-organization.

All these things may seem to be quite natural, upon which there is no need to dwell at length. But the reality far from fully corresponds to them. Very often it was, and still is, observed in history that for moments of crisis, of whose inevitability there were no doubts and whose general character was foreseen, an organization proved to be fully unprepared for the rapid fluctuations of forces. Facts like that are objectively enough established by confessions, sometimes repentant and sometimes indignant, of official and competent actors of these organizations<sup>10</sup>.

Leaving aside that part of unpreparedness, which, as sometimes happens, follows from the objective impossibility of preparation even with the greatest efforts, for instance, as a result of the lack of sufficient forces, violation of the elementary tektological principle can be explained as follows. Organization in practice lives much more spontaneously than its actors think. It does its work along the line of the least actual resistances, by *submitting* to this law, and not by the line of the utmost impacts in the observable future, by *using* this law as an instrument to achieve its goals. This spontaneous practice usually suppresses the reasoning of its leaders, and when they are warned by those whose experience and vision are broader, the inertia of the whole outweighs them. The warnings may even meet general consent — a need to strengthen against these or those threats and shocks is recognized — but things still go along their routine course.

We see now, how broad and tremendous is the practical importance of the law under our study. But for our age its explanatory power is precious as well, maybe to a greater extent than for any other. It alone is capable of resolving a whole number of the painful cultural puzzles of our age, which seem to undermine all our faith in the development of human sociality — the basic meaning of civilization.

Herds of millions of people belonging to the most cultured nations and the most advanced classes before our very eyes dash to exterminate each other with the same zoological cruelty as their savage ancestors. London and Paris, the great centres of world culture, witnessed nationalist massacres<sup>11</sup> similar to those of semi-Asiatic Moscow. The Armies of the most advanced nations were as tremendously brutal as the Kurds and Cossacks, Ingushs and Moroccans. The gentlemen officers of liberal England shot Russian revolutionary prisoners of war in concert with the generals of tzarist despotic Russia. Not only the priests of obsolete religions, but also the most cultured intellectuals, poets, artists, even people of science were at the head of the general ferocity, etc. Does this mean that there is only progress in technology and the external aspects of life, but no progress of human nature? Is it enough for the whirlwind of life to tear off the paper overcoat of civilization from a European to show us an everlasting troglodyte?

In reality this is not the case, and the explanation of the striking contradictions is provided by the law of the least favourable conditions.

The structure of modern capitalist society is heterogeneous to the utmost degree; it represents, as some German professor has put it, a "gradation of the most diverse existences". Meanwhile, the inferior levels of sociality differ in different countries much less than the middle and upper ones: a London hoodlum of the bourgeois class or

an ignorant savage from the lonely quarters are, in their abilities and intentions towards destructiveness, quite similar to the corresponding types in Russian capitals. Imagine, that in London out of its 6 million inhabitants there is only one per cent, i.e. 60 thousand, of these elements; and when some social disaster gives them a slogan and the possibility to unite, it is quite sufficient for them to arrange a cruel massacre, for instance, of all German tradesmen. It is probable that in Moscow out of 2 million people, 90 per cent are of that level, i.e. one million eight hundred thousand; in similar conditions they carry out a similar massacre, and the size of the destruction does not exceed that of London, because its target is no more than there. A tremendous inequality of culturedness is masked by the similarity of the inferior complexes of the cultural system.

There is even more to it than that. The modern cultured individual, taken separately, is not a homogeneous whole. His psycho-motor system contains a gradation of layers: from inferior to superior, from the animal instincts of a cave man to pure social idealism in those various forms peculiar to the various classes. And again, when an external impact, directed towards the inferior complexes of their psycho-motor system, is powerful enough to overcome their inertia and to outbalance them, two individuals can be equally spontaneously destructive, although the inferior group of reactions of one constitutes, maybe, one tenth of that of the other.

This "levelling by the inferior" is most often manifested in the herd actions and emotions of a crowd. A crowd is a collection of individuals united on the basis of physical affinity through direct imitation. Its actions are focused on that group of physiological reactions which are common to everyone; but these are the most inferior; for those that are superior — with their complex diversification — discrepancies are much broader. Therefore a man



in a crowd, who has only the rudiments of zoological heredity in his soul, can be as cruel as any other, whose heredity dominates over his sociality; and a man of courage, who, under the normal excitation of his psyche could meet the threat of his death fearlessly, can succumb to panic, behaving like a weak coward, etc.

The law of the least favourable conditions will severely dominate mankind — unless mankind can capture it. For tektology, there is a problem here: how to capture it in the field of culture, so that there would not be, anymore, such a levelling by the inferior, which submits civilization to the rudiments of savagery inspite of the fact that they are much weaker than the activities it has accumulated. This is the problem of the organizational transition from inferior values towards the middle; and its basic solution implies another step in tektological research — the formula of the leasts is not sufficient here.

#### § 4. Even And "Rosary"<sup>12</sup> Structures

The structural stability of any system can be analyzed in still another dimension. Its environment acts upon it directly, as it acts upon the environment, only where they are in *contact*, in the boundary area — in the tektological, rather than purely spatial meaning of this word. The size of the boundary area, that is, the number of contacts, may increase or decrease. For instance, when a turtle pulls in its head and paws or a man shrivels, the number decreases; when a political organization sends its agents and propagandists to regions or social circles where it has not been working before, it increases; this is also the case for a scientific theory when it spreads over new groups of phenomena, etc. Two complexes, two systems, which are similar and equal in all other aspects, in this one may differ. So the

problem arises of how these alterations or differences tell upon structural stability.

Here is the simplest case. Two bars of equal length, say, one meter long, are made of two equal quantities of the same metal, but one of them is of uniform thickness over its length, and the second is of "rosary form", with alternate narrowings and widenings. In a great number of cases their properties turn out to be different. The rosary-formed one is less resistant to fracture; if the environment is such that it can oxidize it, then it will also rust sooner. In a cold environment it will lose heat more quickly; but in a warm one it will be sooner heated. Its static electric capacity is greater, as well as its electrical resistance, etc. All of these are consequences of the expanded surface, of the greater number of contacts with the environment.

Certainly, it makes no difference whether the talk is about a physical surface, as in our case, or some other form of contact with environment; the more of them there are, the lower is the concentration of activities-resistances which account for a unit of boundary area; and with "rosary forms" this concentration is non-uniform, being variable from one point to another. Therefore, in accordance with the law of relative resistances, destruction of these forms, their de-organization is made easier.

In a more general form it can be expressed like this: negative selection is more intensive for "rosary forms". For instance, the cooling of the bar is a negative selection of its thermal activities; it occurs sooner in case of a rosary-formed bar than that of a straight one.

The structure which is more straight, less differentiated, generally, the one which is opposed to rosary forms, we shall refer to by the term "evenness".

The same differentiation can be applied to psychological associations, on the one hand, and ideological systems, on the other. For instance, in the primitive consciousness of a child there are, for example, groups of psychological representations, one which pertains to quadruped animals, another group pertaining to birds, and a third refers to people, which are, separately, continuous wholes. But all of them are associated by diverse, more or less casual similarities: an owl looks like a cat, a frog — like a naked man, a bear standing on its hind legs looks like a man in a fur coat turned inside out, etc. These weak associations make one "rosary" system of these three groups. Scientific classification proceeds in a similar way, but here the group associations are less casual, more stable. For instance, the conceptions of the species of the class of mammals, class of birds, class of reptiles etc. are, separately, comparatively even complexes; but between them they are associated much more weakly by the abstractions of their common properties into a "rosary" chain of genuses, and the even more "rosary" rows of families, etc.

The difference everywhere is that more even forms contain more links between their own elements than "rosary" forms, so there is less space between them for the penetration of the elements and the complexes of their external environments, as the sea penetrates with its bays into the hollows of the mainland; so "rosary" forms contain more such "hollows".

So, negative selection is less intensive for more even forms. But what of positive selection? Certainly, it must be also less intensive. Where heating occurs, i.e. where thermal energy is more assimilated than de-assimilated, a rosary-formed bar will, during the same period of time, acquire more thermal energy. The more the number of contacts with the environment, the greater the comparative assimilation from it will be.

This is a general answer to the question of which structure is more favourable for the preservation and development of complexes: *it is "even" under negative selection, and "rosary" — under positive selection.*

This is known to the turtle, which withdraws into its shell on the occurrence of any negative, from its point of view, events, and to the man, who shrivels from cold. But scientific, tektological formulation gives the opportunity of a simple and easy solution to a number of organizational problems, which in their usual form of statement seem to be complex and difficult. As an example of this we can take the problem of the advantages of "centralist" and "federalist" types of organizations under different conditions.

Of these two types the "centralist", as it is commonly understood, i.e. one characterized by the existence of a centre, to which all other parts of the system are attracted and closely connected, is more even; the "federalist" type, with its weaker connexions between relatively autonomous parts, is an example of the "rosary form". For instance, tzarist Russia, bureaucratic republican France were centralist; in comparison with them, pre-war England, the United States and Switzerland were federalist; in the case of political parties the strengthening of the power of a steering centre expresses a tendency towards evenness, and a consolidation of the autonomy of local and specialist organizations — that towards rosary-ness; a religious sect with a definite and strict dogma, which is approved by all its members, is more continuous than a scientific or philosophical school, which includes different nuances or currents, etc. This characterization, along with our general formula, must suffice to show that the "federalist" structure is more beneficial under favourable conditions of life, and the "centralistic" — in unfavourable situations, when selection is negative. In the first case the autonomy of the parts allows them to be better developed, to

utilize to a greater extent the influx of energy, provided by the social and natural environments; in the second case, their closer and more stable relationships can be sustained for a longer period against destructive influences. This can be illustrated by innumerable examples.

The state systems of Switzerland, the United States, England with its extensive local self-government inside the country and federative colonial relations were possible only as a result of the exceptionally favourable conditions of life provided to them by historical fortune. On the contrary, states which developed in lengthy cruel wars, surrounded by enemies could hold out only on a centralist basis; such were the Eastern despotic states, Russia and France. Similar correlations are manifested by political parties: hard external conditions are endured more easily by more even structures, for instance, factioning is especially harmful to them, as, particularly, is shown by the experience of the Russian political parties in the period of reaction. During the extreme deterioration of their situation the relationships between central and local organizations, which expressed the "rosary" aspects of party structure, were inevitably broken and the party turned into a number of practically uncoordinated groups. Where the unity was sustained, it was only the unity of the program and dogma, which became more stringent; this was also the even type but of another kind, namely, ideologically even.

An illustration from psychology is provided by the mental states, which Aristotle called "macro-psyche" and "micro-psyche", the widening and narrowing of a soul. Pleasant, joyful perceptions, which correspond to a growing influx of energy into the nervous psychic system, make a person unfold his communications with his environment in all directions — his outer senses are intensified, his liveliness grows, his "sympathetic" tendencies strengthen, etc. On the

contrary, distressing, painful perceptions, which express negative selection, call forth a sort of rolling up of the soul, a slackening of attention to his surroundings, a weakening of all his perceptive activities, the reduction of his contacts with other people, a desire for peace and quiet, etc. This is the way the organism adapts itself and shifts from more "rosary" to more even correlations and the other way round — human psychology conforms to the same law as the turtle.

We have adopted the terms "rosary" and "even" only conditionally, for we could not invent better. Their shortcomings are not confined to the fact that they imply an idea of physical structure, while the question is one of organizational combinations of whichever nature. Even for physical complexes "rosary-ness" and "even-ness" don't always correspond to the particular images which are unintentionally associated with these words. It should be remembered that the question is one of the relative number of contacts with the environment and no more than that. If we compare two cylindrical bars of equal volume and equally even along their lengths, with no widenings or narrowings, they can still differ in the same respect. One is shorter and thicker, the other is longer and thinner; the first bar has a smaller surface than the second one, and the latter will show more "rosary" properties than the former: it can be more easily broken, it is more quickly heated and cooled, as well as rusted, etc. But if we shorten and thicken the first cylinder until it takes the form of a disk, it will also manifest "rosary" properties. The most "even" body is a sphere with a uniform inner structure. But if the material is not homogeneous along different directions, as is the case for many crystalline bodies, then the most continuous form is that of an ellipsoid with a certain proportion of axes, etc.<sup>13</sup>.

So, "rosary-ness" can be characterized in general by the *non-uniform relationships between different parts of a complex or along*

*different axes*; the more uniform they are, the greater is the "evenness". It is interesting and important to note that these concepts are fully applicable not only to spatial, but also to temporal structural relationships.

So, many complexes of activities alter over time in an undulating manner, as if they expand and contract. All oscillating processes in general — psychological and organic, molecular and ethereal — can be represented as currents, which expand and contract along their way; by representing it in graph form we apparently get "rosary forms". And all the previous conclusions about these forms remain in effect here. For instance, if we compare waves of the same nature, for example ethereal or light waves, "rosary" characteristics are more clearly manifested by those that are shorter. Once manifest in the world, all waves are, in this or that manner, absorbed by its various complexes — by matter dispersed in it, and maybe by the ether itself. Therefore, they are negatively selected. And from this it follows that for their stability the less "rosary" forms, that is, those with a greater wavelength, are more favourable. Indeed, the shorter are the vibrations, the more easily they are absorbed by minor opaque particles; those that are longer are not absorbed, it is as if they bend around these particles in accordance with the laws of so called diffraction. Since the energy of rays is partially absorbed as a result of the incomplete transparency of the medium, the violet rays — which of all visible rays have the shortest wavelength — should become weaker in comparison with all others, especially the red rays. Physical theory accepts this; spectral analysis seemingly confirms it: in the spectrum of the most distant stars the violet rays are comparatively weaker in contrast to the spectrum of closer stars of the same type<sup>14</sup>.

The life of the human organism also progresses as a kind of oscillation: during the day it is more active than at night, in summer

— more than in winter; it forms a sequence of widenings and narrowings. Generally, in the life of humankind positive selection predominates: it grows, and its powers increase. Under these circumstances temporal "rosary-ness" should be more favourable to it; and indeed, at the cost of the night-time reduction of the work of the organism, its day-time intensity grows; the greater is the amplitude of this vibration, the day-time intensity of work is correspondingly higher and people are more easily able to overcome the resistances of nature. But if the organism finds itself in a situation of negative selection, for instance, of chronic malnutrition, the proportion is reversed: the greater is the amplitude of the day's vibration, i.e. the more intense is the day-time life of the organism, the less the extent to which it can endure it; and a Russian peasant, for whom this amplitude is smaller, can sustain himself, other conditions being equal, for longer than an English worker.

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

It should be noted that we considered the problem of the significance of "rosary" and "even" structures when applied to an *indefinite* environment, to the conditions of positive and negative selection *in general*, and studied different and variable influences which were not concentrated especially on certain parts of the complex. But where such stable concentrations of external activities really take place, we have, of course, a task with definitely changing conditions, and the problem can no more be reduced to a greater or smaller number of contacts. For instance, if negative selection is most intensive in one of the parts of a system, then in order to protect the whole it is desirable that this part be more highly developed; that is, even under negative selection a certain *unevenness* of relationships is beneficial. For example, in all mechanisms, the parts of it which are subject to intense friction, pressure, torsion, strain, are made either



more massive or from more durable, i.e. tektologically more even materials; and this, of course, attaches to the complex a more "rosary" character; evenness would be unfavourable here. But this only demonstrates that *definite* and *particular* correlations always confine and modify the application of general schemes which represent indefinite correlations.

### §5. Systems of Equilibrium

Structural stability is expressed in the "law of equilibrium", as formulated by Le Chatelier (for physical and chemical systems), but which, in fact, is a tektological, or universal law. A system of equilibrium is that which preserves its given structure in a given environment. A typical illustration of this is a set of scales in a state of rest. If one of the sides is pressed upon, for instance, by a metal weight, it starts to descend, and the other — to ascend, while the horizontal yoke becomes slanted: this is a structural change. But as it happens, the system itself produces counter-action: the side with the weight drops with some deceleration and only to a certain point, after which a reverse motion may begin, and the swaying is followed by a new, altered equilibrium, which is determined by simple mechanical conditions.

Here is a more complex illustration: water and ice in a vessel under 0 Centigrade, i.e. the temperature of freezing and melting. If the vessel is heated, part of the ice absorbs the incoming thermal energy, turns into water and counter-acts the effect of the heating: thus the temperature of the mixture is sustained until all the ice is melted. And if, instead of heating we expose the mixture to higher pressure, then a part of ice, again turns into water, whose cubic capacity is lesser, thus counteracting the increase of pressure inside

the mixture. A mixture of liquid and solid mercury in the case of heating also reacts by melting, which counteracts the change of temperature; but in the case of the raising of the pressure its reaction is the reverse — a part of the mercury will freeze. Why? Because mercury, like the vast majority of bodies, occupies in solid state less volume than in liquid, and therefore the rising pressure in the mixture is counteracted not by melting, but by freezing of the mercury; and so it occurs; water, as an exception, manifests the reverse proportion of capacities, and so the counteraction is achieved in the reverse way<sup>15</sup>. If a saturated solution of some salt contains its crystals, then by heating or by cooling the system, or by varying the pressure on it, we get further dissolution or sedimentation with an absorption or emission of heat or a change of volume and pressure in the direction opposite to our influence. An electron, moving at constant speed in the ether, acquires an "additional mass" in a direction corresponding with any change of this speed; that is, the system "ether — electron" produces counteractions to the changes of speed. When a constant current circulates in an electrical conductor, any change of this current calls forth so called self-induction, which, being opposite to this change, diminishes it, etc.

Le Chatelier's law is formulated as follows: *if a system of equilibrium is subject to an influence, which alters some of the conditions of its equilibrium, it produces processes directed so as to counter-act this change.*

It is a long time already since experience demonstrated that this law can be applied not only to physical and chemical systems, but to many others as well. For instance, living organisms in normal circumstances behave towards external influences in a similar manner. If a human body is exposed to cooling, it immediately intensifies the oxidizing, and other processes, which produce heat;

and when heated externally, it increases the diaphoresis accompanied by evaporation which absorbs heat, the converse is the "shrivelling" caused by cold, the surface of cooling is decreased; and when a turtle, under any unfavourable influences hides itself in its shell, it does so in order to decrease the surface area which is subject to external influences. In accordance with the law of Weber-Fechner, perception grows, not linearly with the growth of external irritation, but in proportion to its logarithm, i.e. comparatively ever more slowly<sup>16</sup>; this means that, with the growth of external irritation resistance to it is growing more and more rapidly, so that the energy of the most powerful irritations reaches the nervous centres in the lowest concentrations, these centres with their subtle sensitivity and delicate structure would otherwise be rapidly destroyed. For example, the human eye can perceive the light of a star of sixth magnitude; but the luminous irritation caused by the Sun's disk is ten million million ( $10^{13}$ ) times greater: whose brain could directly endure influences which differ that much in power?

It can be demonstrated by simple analysis that the law of equilibrium is applicable to any system which preserves its structure in a given environment. Let us start from a comparatively simple and rather typical illustration: the system "water and ice under zero Centigrade". Suppose that it is heated. In accordance with modern scientific symbolism this means that the vibrations of the molecules in their environment become more intense and the collisions, transmitted between the molecules of water and ice — more powerful. The energy of the motion of these particles, expressed by their "temperature", is an activity of the same order as their coupling, it can conjugate with it and paralyze it. This is what happens here.

The heated molecules of water transmit their surplus energy through ever more powerful collisions into the surrounding molecules of ice.

This surplus is paralyzed by the activities of the couplings of the ice until they are equal; resulting in full disingression, which, as we know, produces the breaking of relations: the marginal particles of ice are torn off and turn into a mass of liquid water. All the surplus thermal energy, acquired by a particle up to this moment, is spent in the struggle against its coupling activities, in order to paralyze them: therefore the kinetic energy of the particle is no more than it was before, and its temperature is again zero Centigrade. The same process occurs with other particles of ice. So, the heating of the whole mass of water in contact with the area of ice results in the previous temperature of zero Centigrade being maintained and counteracts the heating, as long as all the ice is not melted.

If the case is not of heating, but of growing pressure, the kinetic energy of the particles of this environment does not on average increase, but what is growing is the number of collisions affecting the boundary area of the system. The surplus activities of pressure here also are transmitted from one particle to another inside the system. They increase the frequency of the collisions of the particles, thus driving down the amplitude of their motions. And again these incoming activities can conjugate and enter into disingression with the couplings of the molecules of ice; the disingression tears them off and adds to the liquid, and, since the volume of water is less than that of ice, the pressure falls.

But as we have mentioned already, water is an exception. If we consider another similar system, for instance, "solid mercury — liquid mercury", we observe the opposite. The surplus activities of pressure enter into disingression, not with couplings of the particles of the solid body of the system, but with the activities, which counteract the couplings in the liquid. Additional pressure diminishes the amplitude of the motion of the particles of the liquid, so that this amplitude becomes less than the distance between

particles and they vibrate in a manner not transcending each other's paths or mixing freely, but remain around some middle position: and this is the way the particles of a solid body behave. So the freezing of some portion of the liquid takes place; but in this case its volume decreases, which, as in the case of ice melting, diminishes pressure.

So why do activities of the same kind — the force of pressure — by disingression paralyze in two different cases not similar, but directly opposite activities, as if they *select* those which are in accordance with the law of Le Chatelier? Selection indeed is the case here, but this is, of course, not conscious, but *spontaneous selection*.

Scientific theory represents molecular motions in the form of innumerable and variously directed "infinitesimal" activities. If a system adopts from outside new activities of this kind, we should consider *all possible* combinations of them with those which had existed before, *all possible* elementary collisions, conjugations, disingressions. Some of these combinations will be stable, and the others — unstable; the former will be sustained, and the latter — eliminated by selection.

For instance, the activities of external pressure in the system "water - ice" will enter into disingressions partially with the motion of the molecules of water, transforming them into a solid state, and partially — with the couplings of the molecules of ice, thus melting it. But since ice occupies a larger volume than the water from which it was produced, in the first case the pressure grows, while in the second it falls. The problem is: which one of these transformations will turn out to be more stable?

The answer depends on the structure of the system in which these processes take place; and while this is unknown, neither of these possibilities can be excluded. But we should remember that precisely

the same processes took place in the system earlier as well, before the influx of these new activities: some particles of water were transformed into ice, increasing internal pressure, and some particles of ice turned into water, lowering internal pressure. If some of these transformations were more stable, the whole system could by no means be considered as a system of equilibrium, its structure would be permanently modified: in the first case in one direction, in the second case — in the other. But this was not the case: those transformations, which transcended a certain limit, immediately became less stable and were eliminated by selection. Modern scientific thought characterizes the structure of systems of equilibrium precisely in that they contain opposite processes, which neutralize each other on a certain level. The matter is represented in such a way that on this level the tensions of opposed activities are equal; and when one of these two processes is strengthened and rises above this level, the tension of the corresponding activities becomes stronger and flows in the opposite direction, as water, rising above its average level, falls. Thus the equilibrium, and along with it the stability of the system are sustained in ordinary circumstances.

Now we can conjecture how the external activities of pressure in their different conjugations and disingressions determine the transformation of some particles of water into ice, and of some particles of ice into water. Transformations of the first type, by increasing pressure, create new differences of tension, which move the flow of activities in the opposite direction; therefore, these transformations are unstable and eliminated by selection. Transformations of the second type, the lowering of pressure, which had already risen above average, diminish the differences of tension and do not instigate a reverse flow of activities; consequently, they are more stable than the former, and selection is more favourable toward them. The result is just that which obeys the law of Le

Chatelier: it is evidently this process which diminishes the effects of external influences, as though counteracting them.

In the case of mercury, on the contrary, the transformation of solid particles into liquid increases pressure, and the transformation of liquid into solid — decreases it. Therefore, under external pressure, processes of the first type by increasing the differences of tension are less stable, while processes of the second type by decreasing it are more stable. The general result of this selection, which is the opposite of the former process, is again in accord with the law of Le Chatelier. And evidently the same thing should take place for any system of equilibrium, whatever activities it consists of and whichever opposite processes would neutralize each other within it. For instance, our organism constantly produces processes which emit and absorb heat in approximate equilibrium in a given environment; if the environment becomes warmer, heat-loss processes are intensified, and when it is chilled, the opposite, heat-producing processes become stronger.

But all of this pertains only to *systems of equilibrium*. With non-equilibrium systems things are totally different. Even if transformations are going on here at the same time in two opposite directions, one of these groups is more stable, and therefore the whole is transformed step by step in this direction. What are the outcomes of external influences upon complexes of this kind?

This can be illustrated by the mixture of hydrogen and oxygen, which is called "fire-damp". At normal temperatures it seems to be an equilibrium system, and no existing methods can trace any chemical transformations going on in it. However, in fact they take place: the mixture is transformed into water vapour, i.e. the process of hydrogen and oxygen fusion outweighs the opposite process. But this reaction is going on so slowly, that by approximate calculations

based on observations of its progress under higher temperatures and the formulae of measurement of the speed of reactions discovered by van't Hoff, it would take hundreds of billions of years to complete it. This is a system of *false equilibrium*, it is not balanced chemically or thermally, for the reaction emits heat and the mixture is self-heated, even if only elusively.

Let an external impact, heating, be applied to it. The internal transformations of the complex in this direction are already more stable than the opposite and the same is the case for the newly added activities. It is not only that there are no counteractions to them, but the process of the fusion of hydrogen and oxygen is accelerated, causing an additional heating of the mixture, exactly the opposite to that which takes place in systems of equilibrium. Under temperatures which are close to normal, this is again insignificant, merely elusive values; but the higher the temperature, the more rapidly it grows; and at about 600 degrees Centigrade it becomes so high, that the process is accelerated to an explosive level, which, in its turn, produces heat of several thousand degrees<sup>17</sup>. However, this explosion is nothing tektologically new — it is a continuation of the process which was going on before it; only its speed has changed.

Such is a "false equilibrium". These words imply, therefore, two facts: firstly, that the equilibrium is constantly violated towards some direction, and the complex is in the process of transformation; secondly, that we do not observe it directly as a consequence of the imperfection of our sense organs and methods of observation. Even when we speak about "true equilibrium", we do not mean a strict, full equilibrium, but only a tendency towards it caused by bilateral vacillations. If a crystal of salt is immersed in its saturated solution, this is a "true equilibrium" in the sense of water and ice under zero Centigrade. In any given moment there is no strict equality between the dissolution and sedimentation of crystals, the melting of ice and



the freezing of water; but if one process outweighs the other and there is a digression from this balance in some direction, then in the next moment the opposite tendency will dominate, the vacillation will be moved in the opposite direction, etc.

Differences between equilibrium, non-equilibrium and especially "false equilibrium" systems are of tremendous significance not only to cognition, but also to the practice of life. It is very important to *recognize* these types in order to foresee the possible developments of a certain system. And this is especially important where this law has not yet been strictly formulated or consciously applied, in the realm of the most complicated phenomena — of life, of psyche, and of society. Let me illustrate this point.

If the herbivorous Greek turtle is lightly struck a blow, it immediately draws its head, paws and tail into its shell. Thus the surface area available to hostile forces, and, therefore, their direct action, is reduced, which fully accords with the law of Le Chatelier. This shows that the character of its psycho-motor reactions correspond to the principles of systems of equilibrium, they tend toward stability and are conservative. So we should not expect from a turtle, for instance, the progressive development of its behaviour, its active conquest of the environment, in contrast to organisms of the opposite type.

Imagine that the turtle were to behave in another manner — that to external violence it responded by thrusting its paws and jaws outwards. In the common use of words, this would be an actual "counter-action"; but it would be gross error to see here a correspondence to the law of equilibrium: this is a directly opposite thing, and the misuse of words should be removed here from the very beginning. By its "counter-acting" motions the turtle would *directly* increase, rather than reduce, the differences of mechanical

tension, which determine the immediate outcome of the external influence; only its consequences — the elimination or flight of the enemy — might cause an actual reduction of hostile activities; but when the enemy is stronger it might well lead to the opposite outcome. This is the principle by which the well known rough bear trap works: a log, suspended so as to prevent the bear from reaching a beehive and so as to be able to swing like a pendulum. The bear again and again pushes it away and receives more and more powerful blows from the log, i.e. the sum of mechanical differences is conserved and accumulated. The law of Le Chatelier refers to the inner processes of a system, the inner re-groupings of its activeness, which *directly* reduce the outcomes of external influences. Acts of struggle against the cause or bearer of this influence are not like that at all; and therefore they indicate that these cases are *not* of systems of equilibrium.

As was mentioned above, human organisms react to intensive external heating by intensified evaporation of water, which absorbs heat; this is fully in accord with the principle of Le Chatelier and shows that in its direct thermal relationships with environment the organism is a system of equilibrium. But along with this reaction, other, nervous-muscle reactions frequently take place as well: the man fans himself with a feather, opens the windows, etc. These motions are accompanied by the transformation of chemical and mechanical energy into thermal energy, and consequently, taken as they are, lead to an even greater heating of the bodily tissues. Hence it is clear, that in regard to its motor neuro-muscular activeness the human organism is a non-equilibrium complex. And we should remember that, in general, one and the same system can always be a system of equilibrium as concerns some of its activeness, and overtly or covertly a non-equilibrium system as concerns others. For instance, the above mentioned fire-damp, which under low temperatures represents, chemically, a false equilibrium, can, in a

mechanical sense can be considered as representing true equilibrium: to increased pressure it reacts with higher density, and vice versa.

Systems of equilibrium can be comprised of non-equilibrium complexes, and vice versa. For instance, a turtle in regard to its motor reactions is a system of equilibrium; but each separate motor reaction violates the equilibrium of its nervous-muscle apparatus. Non-equilibrium organisms are comprised of cells, which usually tend towards equilibrium, etc. And, generally speaking, the tendency towards equilibrium arises out of innumerable partial violations of equilibrium.

The importance of these schemes of equilibrium and non-equilibrium for human practice is tremendous. Let us consider the following illustration: a man is suffering from the unfavourable impacts of his fate — insults, oppression, losses, various misfortunes, etc. How will he react to all this? There are two basic types here.

Some natures manifest a tendency towards self-restriction: patience, submissiveness, resignation; often they are accompanied by reduction of the man's needs — "asceticism", and even of his contacts with other people — "hermitage". What is the meaning of these reactions? The external environment with its hostile forces reduces the vital activities of the psychic system; and the latter diminishes its active manifestations, and thus makes narrower the area of its contacts with the environment; so it directly reduces the sum of unfavourable environmental influences, as in our example with the turtle. Certainly, here the principle of Le Chatelier is manifested; this is the response of systems of equilibrium.

Other natures take a more offensive attitude towards the environment; they fight vigorously against its hostile forces by

expanding their active manifestations, increasing their tension. The losses of energy, induced by negative external impacts, become even greater as a result of waste during the struggle, the sum of its contacts with environment, the depth of the environment's penetration into the system, generally everything that we can call the "vulnerable surface", becomes even greater. This is the very opposite of the principle of Le Chatelier, and indicates a complex of non-equilibrium type.

It is clear that natures of the first kind are incapable of practical progress, the development of their powers or victory over the environment; natures of the second type are capable either of development, progressive victories over external forces, or degeneration in the course of defeats; frequently both attitudes are mixed in different proportions, for instance, it is not infrequent in the artistic world to find creative development combined with a destructive dissolute life; even more frequently one is replaced by the other, non-equilibrium progress by non-equilibrium regress, for example, when conditions are abruptly changing in a negative direction; but the reverse is also possible. And natures, which tend towards equilibrium, being incapable of *developing* their resistance to the environment will, in the process of the exhaustion of their resistance, naturally degenerate.

But again we should remember that all tektological definitions are relative. A man, who tends towards equilibrium in some aspects of his life, can be positively or negatively unbalanced in the others: a "citizen" or even "revolutionary" in political life, can be "narrow minded" in his family relationships, or a person "of petty interests" in all his contacts with society can be "high-handed" inside his own economy, etc.

The prevalence of this or that psychological type depends on social conditions, that is, the structure of the society, the direction and speed of the development of the society in general or its separate groups or classes. So, social ideologies also reflect tendencies, which correspond to these types. And since the completion of any ideology, its final characterization is expressed by the *ideal of life*, it accentuates this or that tendency most distinctively. The bias of a collective toward equilibrium is manifested by the ideals of passivity and indifference; the purest and most complete of them is the Buddhist "nirvana", the absolute equilibrium of the soul, its absolute calmness, the undisturbed contemplation of eternity. Ideals-dreams also pertain to this type; such is the Christian ideal with its idea of justice in the next world, of compensation to all who suffer and are humble and obedient, of the punishment of those who are wicked and haughty, this punishment being carried out not by the efforts of people themselves, but by the deity, the supreme world activity, who restores the equilibrium violated by earthly life. These pleasant dreams represent a psychological reaction to the hostile influences of the environment, a reaction of "self-consolation", which fully obeys the law of Le Chatelier: the inner counter-action of the psyche against the pain caused by destructive external forces.

The other group is represented by socio-practical, actively organizing ideals. To the utmost degree, such is the ideal of labour collectivism.

The first ideal is characteristic of those societies, groups or classes, whose life has become stagnant in its established forms or which are giving up their positions, being unable to defend them successfully; the second group pertains to the developing collectives, which win over natural and social resistances.

Systems of equilibrium may turn into non-equilibrium systems and vice versa by means of structural change, which often cannot be observed directly. Transformations of this kind are in practice very important: most often they can be discerned by a change of the system's reactions. Correct evaluation of tendencies toward this or that in interactions between people and organizations, especially during the process of their change, can save them from gross and irretrievable errors. These evaluations are made by people time and again on the basis of "mundane wisdom", i.e. common, lay tektology. From a few observations of how a man reacts to some stimuli from outside, they draw conclusions about his general character: stagnant, tending towards equilibrium, or, on the contrary, possessing initiative, impulsive, urgent, — and thus build their future attitude towards him<sup>18</sup>. Moreover, popular tektology noticed types of false equilibrium, a fact which is attested by Russian proverbs like "demons are hiding under calm waters". But this obscure, imprecise and unstable experience has never been the subject of scientific analysis, and everyone had to master and assimilate it at his own expense.

An even more important thing is to recognize both types in the relationships between organizations — governmental, party, economic, cultural, military — in their co-operation or expectations of victory in case the of struggle. Here the lack of "practical wisdom" in organizations or their leaders can be fatal to them.

For instance, an Army, which reacts to an offensive by its enemy by a reduction of the front-line and a retreat to more secure positions, rather than by attacking counter-manoeuvres, represents the type of system tending towards equilibrium. But this may not be its actual tendency, merely a masking; its true condition can be discerned by slight manifestations of its "spirit", by the character of the partial outbursts of its "activity". But if it really is not capable of initiative

and the progressive unfolding of fighting actions, then, by winning time for re-grouping, for the accumulation and concentration of forces, it still can turn into a system of the opposite type, and its adversary, which has lost this time, can lose everything where there were all the conditions necessary for a complete victory.

Another illustration. A powerful progressive movement appears in an underdeveloped country, democratic organizations are taking shape and growing. This is followed by reaction, a sequence of oppressions, repressions, blows, in general, external insults (hostile stimuli) to these organizations. How do they react to the insults? Let it be the expansion and intensification of their activities, the improvement of slogans, a switch to more radical forms of struggle. This characterizes the organizations as systems of the second type, i.e. it indicates that there is a possibility of their development and victory. But the current struggle exhausts their accumulated forces. And so the time is coming when the vital character of these organizations is apparently beginning to change. They react to the growing pressure by slackening their work, the renunciation of the more acute forms of struggle, the constriction of slogans. These processes are inner changes, which partially reduce the effects of external influences and, in accordance with the principle of Le Chatelier, express a tendency towards equilibrium. Then the issue is resolved and the following triumph of forces hostile to them is ensured: the very possibility of a successful struggle is excluded until new structural changes of the whole social environment take place.

Let us suppose that in this case some sensitive and experienced politician discerns the essence of the situation by analogies to what he personally knows from life or history. But he is able to transfer neither this knowledge nor his sensitivity to other people, and therefore his conclusions are unconvincing to them. It may happen

that at this moment the most lively elements continue to waste their powers in erroneous directions, against the actual turn of the wheel of history. Only the scientific organization of experience can provide a genuine *proof* of conclusions of this type.

With all its broadness and importance, the principle of equilibrium is not a special and independent tektological law. It is a particular application in certain circumstances of the principle we have already dwelt on, that is, the "analytical sum".

Complexes of equilibrium always contain antagonistic activeness, which neutralize each other on a certain level, as, for instance, in the system "water-ice" where they are represented by the molecular couplings and thermal motions of particles, in the organism — by physical and chemical processes, which produce and absorb heat, in common psychology — by opposite, mutually restraining groups of intentions, etc. If a given complex is exposed to an influence, it means that the external environment has produced new activeness, which correspond to one of these antagonistic groups. Let these groups be  $A$  and  $B$ , and the external influence  $B_1$  of the same nature as the second of them. Can it completely, without loss, without partial disingression, converge with it and, consequently, produce a direct, immediate alteration of the system in its direction and to the full extent of its value? As we know, it cannot, ideally harmonious combinations of the former and new groups of activeness are not observed, and to some extent a disingression is inevitable. Therefore, the real sum of this group of activeness will be not  $B+B_1$ , but less by a certain value  $B_2$ , i.e.  $B+(B_1-B_2)$ . In reality, the initial  $B$  was supplemented by  $B_1-B_2$ , which actually expresses the produced change. As we see, it is less than the operating activeness, i.e. the case is precisely as if the system has produced these processes, "directed towards a counter-action" of this disturbing influence, and this is in accordance with the law of Le Chatelier.



The nature of this phenomenon is just that "the analytical sum is always less than the arithmetical sum", as we already know.

These calculations cannot be applied to non-equilibrium complexes, because in the latter case the new influence alters *the course of the already proceeding* structural transformation.

So, things, which are most distant in lay experience, can be unified by tektological laws, embracing all actual and possible transformations of forms.

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<sup>1</sup>In particular, the historical transience of organizations of the "authoritarian" type follows from this. They are characterized by the fact that their "organizing function", i.e. the process of the structural adaptation of the integral system, wholly depends on the individual brain of the "authority", or ruler, while the scale of social life is, of course, a *collectivist one*. Therefore, partial or at least short-term individual insufficiency has irretrievable or even disastrous effects on the whole collective.

<sup>2</sup>There is a joke about an engineer, who suggested that a motorman pass through tunnels 10 arshines high on one end, 6 on the other, and 8 on the average, while the height of the locomotive with funnel was 7 arshines. Of course, there are no such engineers. However, in the past statisticians often adopted as a measure of national welfare the *average* income of the population. When we take incomes as a measure of socially crystallized activities-resistances which people dispose of in sustaining of their lives against elemental forces, as a value expressing the level of *national* welfare, it is the

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incomes of lower social classes that we should take into consideration (An arshine is an old Russian measurement of length approximately equal to 71.12 cm. — Eds.).

<sup>3</sup>The vast majority of modern mathematicians are absolutely unable to comprehend that "area" is nothing other than a body of infinitesimal or even ignorable thickness, and a "line" — a body of ignorable thickness and width. Such is the power of scholastic abstract thought. Meanwhile, it will suffice to consider the following. These areas of *only* two dimensions, which they allegedly "think", as well as those lines of *only* one dimension cannot exist in perception, for they are invisible and untouchable; consequently, they cannot exist as mental representations, for these are traces of perceptions; and they cannot exist as concepts, or be "thought", for the substance of concepts is that they are representations. In fact, mathematicians, clearly, think not what they claim in their verbally contradictory definitions, but entirely different things — areas and lines which are accessible for vision and visual representation.

<sup>4</sup>There is a law in mechanics that bodies move "along trajectories of least resistance". Essentially, this is the same schema. The trajectory of a body is that where relative resistance, when confronted by a motive force, is most probably less than one; the activeness, which in this case is the cause of movement, in other cases can be the cause of the system's de-organization; for instance, a jolt, which can move the body in some given environment, in another (more "sticky") environment, causes it to break. But if we consider the relationships of a body with its environment as some, however minimal, ingressive relationship, then movement — the breaking of the body from its environment — will also imply an aspect of de-organization.

<sup>5</sup>Bogdanov evidently refers to the work: К. А. Тимирязев, "Земледелие и физиология растений", 1906; 2-е изд., М.: Госиздат 1920; и другие изд.; см также: К.А. Тимирязев, Собрание сочинений, т.3., М.: Сельхозгиз, 1937 (К.А. Timiriazev, "Agriculture and Plant Physiology" // Collections of Popular Readings. 1st. edition, Science and Farmer Publishing House, 1906; 2nd. edition, Moscow, State Publishing House, 1920, and other editions. See also, К.А. Timiriazev, Collected Works, Vol. 3, Moscow, Selkhozgiz, 1937). Timiriazev used the expression "Agriculture and Plant Physiology" for the first time as a general title when he published his

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paper "Источник азота растений" ("The Source of Nitrogen in Plants"), in the journal "Северный вестник" ("Northern Messenger"). This paper was later included in various collections of his papers — Eds..

<sup>6</sup>This is an imperfection of language: nobody can say that a bridge has undergone an examination.

<sup>7</sup>It also has its negative aspect, which we will have to investigate further. For now it is sufficient to note that the rule of the concentration of action can solve only those problems which relate to a *finitely changing* environment; and that there a concentrated distribution of activities proceeds correspondingly to the finite change (or differences of its parts). For *infinitely changing* environments, as has been already noted, the method of problem solving should be other; the first method here is insufficient and inappropriate, and its devices such as specialization produce unfavourable results.

<sup>8</sup>The teaching of religion — "Divine Law" — in schools pertains precisely to the rudiments of an authoritarian conservative pedagogy. Religion teaches one to treat life as an order established by a supreme power, where everyone executes his predetermined assignment humbly and obediently, i.e. without initiative or criticism.

<sup>9</sup>New reasons and justifications are often put forward in defence of the rudiments of the past: for instance, school classicism was upheld by claiming that it helps the general development of logical abilities or the implantation of idealism into a child's soul, etc. Here it is unnecessary to take into consideration all these arguments: they would be worth while only if it could be proved that the same positive results cannot be achieved by other pedagogic methods, which in fact prepare the organism for the conditions of its natural and social environment; only then it would be reasonable to regard classicism as an expensive but indispensable solution of the educational problem in its indefinite part (i.e. pertaining to the indefinite changes of the environment).

<sup>10</sup>In the first edition of "Tektology" (St. Petersburg, M., Semenov, 1913) was the following: "In Russia of the recent period of its life all or almost all parties were twice in this situation: both in the period of the upsurge of liberation, and that of the subsequent reaction, and every time the start and probable course of these two crises were most definitely predetermined by certain events. There are all reasons to think

that this situation will occur in the near future for the third time." — And this is indeed what has happened.

<sup>11</sup>Bogdanov uses the word "погром" ("pogrom") — Eds..

<sup>12</sup>Bogdanov uses the word "четочная" which derives from "четки" a set of rosary beads. The intention seems to be to convey an image of the variation of structure — Eds..

<sup>13</sup>The technical importance of "evenness" in this general sense is well illustrated by the mode of construction of houses in Northern regions: by all means possible they avoid creating corners and seek rounded forms — "evenness" makes the area of cooling minimal.

<sup>14</sup>Earlier data about this are now contested by some scientists; but here the problem can be only one of the value of the coefficients of absorption, rather than of its very nature.

<sup>15</sup>The exceptional properties of water are explained in that liquid water is not just a chemical compound, but a solution of ice in varying proportions, which change in relation to a change of temperature or pressure, consequently it submits to the laws of solutions.

<sup>16</sup>In other words, whilst the former grows in geometric progression, for instance 1:2:4:8:16:32 etc., the latter does so only in an arithmetic fashion, i.e., correspondingly, 1:2:3:4:5:6. The correlation here is only approximate.

<sup>17</sup>Only around these temperatures do hydrogen, oxygen and water vapour constitute a genuine system of equilibrium, in which the reaction of addition is neutralized by the parallel reaction of decomposition. Under 3,000 Centigrade this is a combination of 88% fire damp and 12% water vapour.

<sup>18</sup>For instance, during the underground period, the organizers, who recruited new party members, classified all human material into "active" and "inactive" types. The latter, of course, were moved out of the plan.

# ADDENDA

## 1 LABOUR AND THE NEEDS OF THE WORKER<sup>1</sup>

### I

The problem of the interrelation between a worker's labour and needs may be considered from two points of view — physiological and social.

The first is that labour is an *expenditure* of the worker's energy, mainly the energy of his nerves and muscles. An expenditure brings the necessity of a *recovery*, the absence of which leads to the destruction of manpower. The recovery is carried out by *satisfying the needs* of the worker. So labour and needs are life-correlated — one changes when the other changes.

The second viewpoint is the following. Labour is a *social function* of the worker — the expenditure of the collective energy of workers. This expenditure is compensated to preserve and to develop the life of the collective, i.e. the worker's needs are satisfied at the expense of the *social product* or such part of it that a worker gets through some distribution system.

Apparently a solution to the problem of the worker's part of the social product must comprehend both viewpoints mentioned above.

The key to the solution is an idea of organizational *equilibrium*. It is such a very simple idea that it seems to be taken for granted in its formulation. Any organized system including the worker organism or the organization of a collective or a society is preserved since its expenditures and losses of energy are *balanced* by means of the absorption of energy from outside; naturally, it can grow and develop as long as the former are outweighed by the latter.

The idea of equilibrium was applied to social economics by V. A. Bazarov about twenty five years ago<sup>2</sup>. Each element of society, therefore each worker particularly, must get such part of the social product that would give him the ability to perform his social function, his role in the industrial system. *That is an abstract law of distribution*. Like any abstract law it by no means presents a simple description of the facts, it does not say that events in reality always take place just in that way. The law expresses a *norm* of phenomena. Reality almost never corresponds to the norm, most often it oscillates around the norm in one or another direction, deviating considerably from it sometimes. It may happen that a factory does not get from its economic centre, or can not buy at the market the quantity of raw materials, instruments etc., that would be sufficient to carry out its industrial tasks. Hence the factory can not carry out these functions, disbalancing itself, and violating at the same time, the functions of connected factories that use its products in one way or another. The system is partially destroyed or de-organized. Similarly a worker does not often get in the form of his wages the quantity of consumption means that is necessary to support his labour capacity and the lives of the members of his family<sup>3</sup>. But then an expenditure, the partial or complete destruction of manpower, the loss of the energy of social labour and a weakening of society in its struggle against nature takes place.

Apparently it is the law of equilibrium that is implied in Marx's theory of manpower value as defined by the value of the normal consumable means of the worker. One of the most important contradictions of capitalism is the following. Because the general organization of capitalism is anarchic, the most labour intensive of its elements are often unable to recover their living expenditures, while others enjoy surpluses that do not correspond to their expenditures and lead them to regress towards parasitism, that means a partial expenditure of manpower and social product which is not compensated for in society. Sometimes, in several exploitative systems, this kind of de-organization lost its partial character and transformed into the disintegration and ruin of society. Oriental despotic states and the slave owning world of antiquity were all alike: the consumption of the superior classes increased and became more complicated, while their social productive functions decreased and ceased, being reduced to a fruitless waste of social product. At the same time the lower labour classes' share of the social product became less and less sufficient to support their vital energy, so that they degenerated and died of exhaustion. The law of organization or the law of equilibrium displays itself such that its practical violation is incompatible with the preservation of the system and equates to the partial or complete de-organization of the system.

Under the usual circumstances of capitalism, as experience shows, the law of equilibrium is practically observed within a range of a few per cent by means of spontaneous oscillations around the norm. As these infringements remain partial and are compensated in excess by the progress of productive forces, capitalist societies are able to progress.

The same law was fulfilled in a relatively systematic way in the small organized societies of the past, in authoritarian ancestral

communities: the patriarch or director of production gave, to each worker group assigned to special business, the technical means to execute their business as well as the necessary consumable means to support their manpower. The same will take place on a gigantic scale and according a scientific plan in the society of the future.

## II

The expenditure of the labour energy of the worker may be considered from two viewpoints: 1) the *quantitative*, when a total quantity of fulfilled labour is considered in general, in the "abstract" sense according to Marx, therefore, only the duration and intensity of labour are taken into account; 2) the *qualitative*, when the specific, concrete character of certain work, such as that of a fitter, type-setter, miner, etc., is considered, when the specific forms of energy expenditure in the distribution of labour functions in society is taken into account. It is clear that the satisfaction of worker needs must correspond to their expenditure in both aspects, as it is determined by them simultaneously.

It is not so easy to fix the total amount of the worker's needs since these are complex and varied: different kinds of nourishment, clothes, dwelling, cultural needs, etc. The simplest way to observe a connexion between needs and labour on the quantitative aspect is to consider the main group of needs concerned with nourishment. It is most convenient to begin with muscular labour proper. Muscular labour is the result of the energy of oxidation, the "combustion" of foods containing carbonic materials, in the organism. So the role of food here is similar to the role of fuel for a steam-engine and, in the same way as is the case with fuel, the value of food as the origin of labour energy is measured in calories i.e. units of thermal energy<sup>4</sup>.



About two years ago Professor V. G. Groman illustrated a connexion between labour and food treated as fuel, using a living example that is very familiar to us. According to data of the People's Commissariat of Railway Communications, it turned out that one and the same amount of work required in 1920-1921 four persons on average instead of one pre-war worker. Does this mean that the workers have become idlers and lazy fellows? Groman's answer is "No". The point is that the average worker in industrial manual labour consumed in his food 3600 large (i.e. kilo) calories per day before the war. The destruction caused by the war reduced this quantity to 2700-2800 calories. It must be taken into account that 2200 calories from both the above quantities are necessary "dead weight" only: these serve only to support the life of the organism instead of productive labour. Therefore 1400 calories remain for productive labour proper in the first case and 500-600 calories in the second i.e. two and half times less. But then the sum of useful labour will decrease not two but even more times. In the case of decreased nourishment strong exertions become impossible and in the case of slight exertion productivity decreases even more; everybody knows, for instance, that in the chopping of firewood three weak blows can not replace one blow which is three times as strong. The general effect of such work on the lowest level of exertion was normally as much as four times smaller.

A very important law appears here: a deviation down from the norm yields not a proportional, but much greater, and growing, weakening of manpower, the "labour value"-of a man falls much more rapidly than the level of the satisfaction of his needs.

Then practical conclusions follow that may be explained by the following calculation. Suppose that there are food-stuffs for 22 thousands of calories per day and eight real workers. Let us distribute the food among them equally. Then each worker will get

2750 calories and, as we have already seen, he will work at a quarter of the norm. Then all workers will fulfil eight quarters, i.e. two units of the pre-war norm. Now let us try to distribute the same foodstuffs in another way. Let us give the complete normal quantity, namely 3600 calories, to each of three workers only and let them work while we excuse the other five workers from work and share the remainder of the foodstuffs among them: a little bit more than 2200 calories falls to each person's lot, it is exactly what they need to support their life, i.e. a sufficient "social security". Then the first three workers can work according to the pre-war norm and we get not two but three complete units of labour, that is an evident gain of 50% because of a different organization of distribution only. And if we could send four persons out of the eight to the country where they would at once find earnings, though being insufficient but allowing these persons to be supported by half of the security norm, then the remaining four persons could be provided with the proper labour norm and fulfil the work which equals four pre-war units, i.e. the gain is one more unit.

Approximately speaking, these are the ways that, sometimes by planning but sometimes by groping, are chosen by the new economic politics, which in many cases reduces the number of employed workers but increases their earnings at the same time<sup>5</sup>. However, systemicity is particularly important here also so as not to lose forever that labour power which we had to remove temporarily from active participation in production because of the lack of means. A waste of power takes place both in excessive labour as well as in long periods of idleness.

### III

It must be mentioned that nourishment is by no means completely reduced to calories i.e. only to fuel as the source of the muscular

energy of the organism. It needs several others materials: "plastic" materials that serve to restore the tissues being worn out and to repair organs, especially albuminous materials, and also some grease and fat-like materials amongst others; then "transmission" materials such as water, a necessary solvent, in the absence of which vital chemical reactions can not proceed, or iron for haemoglobin that is the transmitter of oxygen inside the blood; finally several "accelerators" such as some salts, ferments, etc., that are necessary to accelerate chemical processes. All these are needed and must be present in a *sufficient* quantity. What will come about otherwise ?

Suppose that there is great surplus of calories in the diet, for example, it contains a lot of potatoes in which "combustible" carbohydrates predominate but that it lacks the *plastic* materials such as meat and milk with its albumens and also contains a small amount of bread where albumens are still contained although in smaller quantities. How then is an organism able to work — according to the surplus of certain elements or according to the lack of others ? Here there is no need to think for long to recognize that it is the lack and not the surplus that dominates since an organism will evidently be destroyed permanently if its labour exceeds the restoration of the tissues being worn out. That is a fatal law of the leasts. The-weakest link has decisive importance in any system consisting of a number of mutually necessary links. For instance, if all branches of social economics need iron but the production of iron has been reduced below the norm then the branches together may work no more than on such a scale that the quantity of iron extracted is sufficient<sup>6</sup>.

Obviously this law concerns not only nourishment but also all other pressing needs that are normal for the worker. Let a worker have everything in plenty but lack footwear. It is easy to imagine then how he will work in winter and how many working days he will miss because of illness. In general if there is a lack of a necessary

and irreplaceable condition then *the whole* pool of manpower decreases in accordance with the absence of the condition.

Several of the "artificial" and "cultural" needs of workers acquire the same pressing character and labour power depends on these also. Labour is quite different in the case where one lacks tea or a smoker lacks tobacco. When the educated, intelligent worker loses his usual newspaper or is unable to read his usual booklets or books his "mood" becomes worse and his labour power decreases. That is why even a small decrease in earnings, forcing a reduction of the satisfaction of such needs, may have a considerable impact on the capacity for work. Therefore the main economic task is to bring about the satisfaction of the needs of all employed workers to a complete norm. Then labour can proceed with a normal and optimal loading. Any reduction here is non-economical.

#### IV

A special quality of a particular labour may be connected with specific needs, for instance, labour in the cold requires an abnormally high calorie intake and special clothes also. Mainly intellectual labour is connected with intensified phosphor nourishment (milk, meat, fish) and monotonous and dull labour means an intensified need for cultural amusements etc. Complete satisfaction of such needs is as necessary as the satisfaction of the general, main needs. Insufficiency of satisfaction will entail results that we already know according to the law of the leasts and it will turn out to be non-economical.

The difficult problem of "complicated" or "qualified" labour appears here. According to Marx, qualified labour is taken into account in social economics in the form of "multiplied simple labour". It is easy to see that as a matter of fact this labour is just an increased or multiplied expenditure of energy.

Labour is a function of the organism as a whole but the main point here is the work of the *nervous centres* the role of which is approximately the same as the role of the operator of a complicated mechanism. So when the complexity of labour increases the expenditure of the energy of the nervous centres increases especially.

The central nervous apparatus consisting of the brain and spinal marrow includes several hundreds of millions of "neurons" or nervous cells with nervous fibres. The neurons are grouped in many thousands if not millions of partial mechanisms for special "motor reactions" or reflexes. Each such mechanism is a combination of "perceptive" neurons perceiving the external tempers of certain organs of the senses and "motor" neurons that receiving impulses from the first send a nervous current to certain muscular fibres causing their contraction.

In the process of simple labour few such elementary mechanisms act but in complicated labour their quantity is much greater and they work under permanent mutual control: each of them must come into operation at certain stages of the labour act in the presence of certain conditions determined by the external senses and stop in the presence of certain conditions resulting from the labour itself, giving up its place to other mechanisms which replace it and come into action at a suitable moment, etc. Expenditures of energy increase not only because of the greater quantity of mechanisms that are involved in this work but also because these contact and interact with each other every time, sending impulses to each other, exciting and delaying each other to a different degree; these processes denoted usually as "attention", "grasping", "initiative", "regulation" represent probably the greatest part of the expenditures in complicated forms of labour. In general it is absolutely clear that the quantity of these expenditures may considerably exceed the quantity

of expenditures that are needed in simple labour and if we knew how many times the first exceeds the second it would be a precise coefficient of the psycho-physiological complexity or "qualification" of labour.

The greater and more complicated the expenditures of energy, the greater and more complicated must be the compensation. This is exactly the basis of the high earnings of qualified workers, a simple and obvious condition for the essential equilibrium of their vital balance, their labour power begins to go to ruin when this balance is not observed<sup>7</sup>.

According to this viewpoint there is nothing incomprehensible, on the face of it in the strange facts mentioned, for instance, in the history of the English labour movement: when wages were decreased, qualified workers preferred the transition to a heavy-worker's labour where the wage was even smaller. Yes, but in that case the expenditure of nervous energy was much smaller too and so the balance was not broken.

We still have not the methods to measure how many times the expenditure of energy in the complicated, physically qualified or intellectual labour exceeds the expenditure in average or "simple" labour. But, fortunately, the problem of distribution as a social and practical task is not set in such a manner. It is set in another way, namely, as following. A society *needs* a certain kind of complicated labour. To support (and to develop in an economically progressive society) corresponding labour power completely, there is a need for certain consumable materials in certain quantities; they cost society 2, 3, 5, 8 times than the sum of consumable materials that is sufficient to support (and develop on the normal average) simple labour power. Thus the value of the complicated labour power is 2, 3, 5, 8 times greater than the value of the simple one, therefore,

correspondingly complicated labour socially equals the same multiplication of simple labour and a society must take it into account as such. Generally speaking a society does exactly that. But under capitalism such taking into account is carried out spontaneously through the labour market with a lot of infringements and, consequently, vital conflicts, suffering and sacrifice. In a systematic organization of the economy it must be done in a socially conscious way on the basis of precise physiological and statistical data about the consumption budgets of labour powers of different types.

V

It is clear from what has been said, how erroneous in principle are the ideas of the *mechanical levelling* of distribution, the naive forms of communism that correspond to the scheme "for everybody equally". The point is that these ideas do not contain real or vital levelling. When one person spends more labour energy than another but both of them gets equal things for recovery, it is clear that real equality is absent here: one of them is comparatively exploited. A particular model of distribution may be considered as economically-levelling only when the relation between the expenditure and the absorption of energy, not the quantity of pay itself, is equalized for each worker. That is what every setting of earnings must aspire to.

However mechanical levelling often still takes place in our country and it results from a moral-ascetic not a scientific attitude. What is its source? To whom does this attitude belong? *The conscious* proletariat can not take any attitude other than an objective-economic one, however we know that many workers still defend simple levelling. Our proletariat come from the peasantry and, partially, from the urban petty bourgeoisie. Complication, or the professional skill of labour, is still expressed weakly in these strata

and was especially weak in the past. That is why the ideology of "levelling" is quite natural here. So one is often forced to deal with the *survivors* of such ideology now.

As an illustrative example I shall mention here the reforms which were carried out in the city of Orehovo-Zujevo at the end of 1920, namely, the transfer of all executives-communists to worker's barracks. One of the enthusiastic supporters of this measure explained it as follows. "...Executives-communists separated themselves from the ordinary living conditions of workers, moving into more convenient places such as houses and flats and so isolated themselves from the broad labour masses and the ordinary workers of the party for a number of reasons: a necessity to carry out work beyond their strength, an intention to preserve the powers of executives and partially because they had not yet got rid of their narrow-minded attitudes. It was this isolation that provided a ground where bureaucratism can intensively luxuriate..."

Further, moving to the evaluation of that decision, the author says: "We, people from Orehovo, did not even momentarily turn a blind eye to the consequences of what had been done and we know that under the conditions of barracks' life our comrades will be forced to expend a lot of superfluous power themselves and that the conditions will probably turn out to be fatal for some of them. But we are profoundly sure that those persons who quit the ranks will be replaced soon and our goal will be achieved. We think that the Central Committee of the Communist Party must demand our decision be carried out obligatorily on an All-Union scale"<sup>8</sup>.

Certainly it happens sometimes that political needs force one to act in such or another way without taking into account economic expediency. That is why we will not judge whether this action was correct or incorrect under those certain circumstances when it was



carried out. We are interested now only in the problem of the conditions of equilibrium between labour and the satisfaction of living needs. How does the matter appear from this viewpoint?

The work of executives is not only complicated but it is even partially creative and requires special nervous tension. That is why special conditions, such as the possibility of concentrating themselves in the process of work as such on one hand, and the complete relaxation of the nervous system during breaks on the other are necessary to achieve success in such labour. Both conditions are excluded by the barracks-cell situation. The law of the leasts is manifested here again. The conditions of labour and rest are "equal to the worst" in every hostel. All infringements of peace and order affect every inhabitant: one nervous, anxious or sick person deprives all the others of their tranquillity and rest too; one person working at night undermines the day-time capacity for work of many others, etc. The "individualism" of the lives of the English and Americans who build their houses so that every family, every flat-dweller and even room-dweller can live in sufficient isolation is undoubtedly one of the causes of their high capacity for work.

The profound difference between the processes of production and distribution on one hand and consumption on the other must be kept in mind. In the first case, collectivism, communism, social unity and regulation mean an increase of power and provide a way to win victory over nature; in the second case, it does not take place because consumption is individual in its essence, and one person cannot really help another here. It is true that in the past joint board, feasts, and joint drinking played an important role in strengthening the social ties between people. It was determined by that on the lowest social levels the satisfaction of such needs gave superior pleasure in one's life and provided unification on these grounds

which served as a means of drawing people together, to create mutual sympathy amongst them. Diplomatic banquets and the official dinners that open business conferences are founded on this principle even now. But feasts that last for hours since all must wait for everybody and everybody must wait for all are unbearably dull or even disgusting as a survival of barbarism for the contemporary working man who knows little about gastronomic delights. As to future generations and their collective-labour aesthetics it will be not easy to understand how people could come together to perform such graceless or even untidy actions as chewing, swallowing, etc., that are performed by everybody only individually. That will be perceived approximately as we already perceive the rough communism of closets which, unfortunately, is so widely spread in our country but has nearly disappeared in the West.

Collectivism in labour and communism in distribution are not connected with communism in the satisfaction of personal needs but are, rather, contrary to it.

## VI

We were already forced to mention "executive" work. What specific type of labour is it and what special needs correspond to it?

It may be a complicated and qualified labour as happens most often, but it may be comparatively simple or even the simplest labour as well. Its special characteristic is that wide possibilities for public good or harm depend on its normal course. The success or failure of a large enterprise together with the fate of thousands of workers etc. depend on the actions of its director-manager: the manager of a large administrative mechanism bears the "responsibility" both of the expedient functioning of the mechanism or fruitless procrastination and a great waste of time and power; a commander

together with the sentry at a powder-magazine and even a pointsman bear the "responsibility" of the life or death of many people.

It is clear that any executive work requires first of all complete and persistent attention distracted by nothing from outside: it is enough to relax or dissipate the attention for the shortest period of time to create an occasion that may cause the failure of important business, a great calamity etc., in accordance with the law of the leasts. That is why every reduction of earnings, every aggravation of living conditions which may bring small material troubles to a worker thus weakening the concentration of his powers on the main point of his work is a gross organizational error here. The principle of the worker's *security* or comfort which releases him from the trifles and catches of life must be carried out here according to the larger or smaller needs of the worker in regarding the level of his labour complexity. Every deviation from the principle is *non-economical* since it will turn out to bring disproportionately large losses sooner or later. It is worth comparing a trifling economy in the pointsman's salary and the several extra accidents which will result from this or to compare the reduction of a cashiers' salary with the dangerous possibility of drawing the cashier into the embezzlement and plunder of the finances which are entrusted to him. That is one of the cases when a widely practical and, consequently, collective economy is directly opposite to a meanspiritedly saving, individualistic and petty-bourgeois economy.

## VII

"Creative" work is a specific, superqualified, type of complicated labour. It is expressed in "creative initiative", "construction", "invention", "research" and generally in solving variable tasks — technological, artistic, scientific or political. This type of work remains the same everywhere. Its psycho-physical characteristic is

not only that very large quantity of elements of the nervous system jointly take part in the work but that new elements must be involved in the process again and again forming completely new and changing combinations.

This does not occur by itself. Psycho-physical stimuli that would lead a brain out of the usual balance of its partial mechanisms are required here. New external effects and variations of impressions which violate the trite course of life play this role in such stimuli. The more intensive and complicated the external excitement the greater number of perceptive-motive mechanisms that it will affect, creating thereby their contact; the less usual the excitement the more unusual and original are the combinations that may result from it in the brain. It is clear that such stimuli must come into the calculation of a consumption rate for workers of the creative type.

Where do these stimuli arise from? Initially they are given to men through their *contact with nature* and its persistently changeable spontaneous combinations. A forest, a field, a river, the air, the sky, and mountains — a combination of conditions once arisen is never repeated in nature exactly. A living connexion with nature is a natural source of creative excitement and it is the most precious and gratuitous source.

But the city, as the present centre of culture, where people live and work in partitioned stone boxes, is estranged from a life in contact with nature, it is alien to nature's powerful, stimuli of creation and it is forced to replace them with artificial ones. Such as theatres, museums, books, meetings, a play of personal feelings, a change of personal connexions, and also temporary changes of situation through travel etc. Mostly these replacements turn out to be expensive and some of them such as the consumption of spirits and drugs, games of chance and lechery are expensive to labour power,

being destructive for the organism. But creative labour needs such or other stimuli and their choice is often determined by simple chance: even the most educated people remain aloof to the idea of regulating their life by means of psycho-physiological knowledge. And since most of such stimuli are expensive, in the sense of their labour value under capitalism, they require a high price be paid for creative labour power. Actually under capitalism they are paid for highly, sometimes even enormously, but of course only in the case where it is valued and acknowledged by market demand.

However, we know that this happens far from often, that in a lot of cases "unacknowledged" workers engaged in creative labour are tortured in a hard struggle for survival using minimal earnings and sometimes jobless, but still they do their business and often they enrich the capitalists who exploit their inventions, publish their books, etc., after their death. Yes, it happens sometimes, and the third type of creative stimuli — the destructive processes as such appear here. When an organism loses its vital equilibrium under the shocks of fate, and the destruction of stable mechanisms takes place in its different parts, at the same time new combinations appear on which creative work may be advanced. Certainly it will be work of short duration which can not reach that maximal broadness which is essential for creativity under conditions of growth and flourishing of life. A machine which is not repaired wears out soonest, resulting in the obliteration of details, damage and breakage. That is one of the cases where vital productive powers are predatorily dissipated under capitalism. Here lies a great false economy. Some isolated and lucky man, such as Goethe, working under favourable circumstances and with sufficient external creative stimuli during his long life creates more than scores living in great poverty, the genius and talents gifted to some of whom by nature were probably not less than those of the lucky man.

In general the creative value of men may vary very sharply, even more sharply than normal manpower under small changes of the level of life's satisfactions. It can be easily shown by an approximate numerical calculation, which will certainly be arbitrary but will express a *tendency* correctly enough. Let a worker's organism be able to develop activeness which equals 1000 units of energy given the complete satisfaction of his usual needs as well as his complete need in creative stimuli. Let us suppose that 500 units are spent for the simple support of the organism i.e. that is as living "ballast". Further, since creative labour is not entirely "creative" but has its trite technical aspect corresponding to the usual types of labour, it also will take a certain part of this energy, say, 300 units. Therefore, 200 units are spent on the creative part of this work as such. Now let us reduce the possibility of the satisfaction of these needs by one tenth: the total sum of activity decreases to 900. The ballast and usual technical functions remain the same but only 100 units, i.e. half the former quantity, remains for creativity. But now it is a creativity at *the lowest level of tension*, therefore, it decreases not twice but even more, say, 4 times. Let us reduce this decreased total quantity by one tenth again that will give 810 units instead of 900; this leaves only 10 units for creativity, i.e. we have a decrease of ten times more still. But the fall of value will probably be 100 times since it is the maximal tension that is the main point of creativity. So an insignificant economy leads to a decrease of creative productivity which is hundredsfold.

The position of a country where similar worthless economies in the earnings of people of initiative, managers of production, inventors, researchers, writers, the organizers of the thoughts and feelings of people and generally qualified constructors of social life were carried out would be absolutely desperate in the world struggle and competition of our epoch.

But the society of the future will take care to ensure that *all* its workers receive what they need by way of the natural stimuli of creativity — a vital connexion with mother Nature.

Our general conclusion is the following. Labour and the satisfaction of needs form the organizational balance of the worker's life. The problem of such balance must be solved theoretically and practically as a scientific and organizational task.

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<sup>1</sup>A Public lecture which was presented in Moscow in autumn 1921 commissioned by the Socialist Academy. Later some additions were made in accordance with new data. The lecture was published in the journal "Young Guards" ("Молодой Гвардия"), 1923, N3 (May), pp. 101-110.

<sup>2</sup>В.А. Базаров, "Труд производительный и труд, образующий ценность" (V.A. Bazarov, "Productive Labour and Labour Generating Value", St. Petersburg, 1899).

<sup>3</sup>Regeneration of manpower in sequence of generations is a necessary social function too.

<sup>4</sup>Any form of energy can be transformed into another hence mechanical or electrical as well as thermal units might be used in its measurement. Thermal units are taken here because these are the most convenient in the case of fuel. The large calorie (i.e. kilocalorie) is the quantity of thermal energy that is enough to warm 1 kg of water by 1 degree centigrade (the small calorie is one thousand times smaller - 1 gram by 1 degree centigrade). The large calorie corresponds to mechanical labour equivalent to lifting 427 kg (approximately 26 poods) to 1 metre.

<sup>5</sup>According to the newest data (N. Sviatitsky's summary in "Economic Life" ("Экономической жизни")) the average productivity of a worker in some branches of industry in 1922 has already risen almost to pre-war levels: production of coils in Donbass - 97% of the quantity that fell to one worker's lot in 1913; leather raw materials - 97%; oil even more - 103%; rubber - 103%; but in the metal-working industry it is still only 32%, in the paper industry - 40%, in the cotton industry 64%, etc. Certainly, besides the weakening of labour power, a charge for the value of worn out and insufficiently restored means of production (disrepair of devices, supplies of fuel, raw materials etc.) is to be taken into account as well.

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<sup>6</sup>We have had cases sometimes where a factory had to work one shift instead of two because of the lack of lamp-glasses, etc.

<sup>7</sup>Some economists explain the qualification of labour and its concomitant increase of earnings by the prior expenditures incurred in the teaching and training of the worker and by compensation for this. We see that this viewpoint is superfluous. As matter of fact it lacks logic as well. The most part of the expenditure for teaching and maintenance of the developing worker during that time is not his own expense but most often it is that of his parents, teachers, the institution where he was taught and, in either case, by society itself ultimately. Why does the society "compensate" for these expenditures? The matter is settled purely by economic necessity.

<sup>8</sup> Л. Королев, "К вопросу об очередных задачах партии" // Дискуссионный листок (L. *Korolev*, On the problem of the current tasks of party, Discussional List, N1, p.15.



## **2. THE ORGANIZATIONAL PRINCIPLES OF A UNIFORM ECONOMIC PLAN<sup>1</sup>**

The problem of a planned social economy was formulated by Marx with great clarity and depth in his critique of capitalism. Marx has shown that all the contradictions of capitalism, all its inseparable calamities and the embezzlement of power, together with cruel aggravations in the form of crises, have a unique general ground — anarchy in production and the absence of the planned organization of production and the social economy as whole.

Since those times this anarchy has led mankind to the greatest downfall that has ever been known in history. It has been displayed in our country with the greatest intensity. Now the problem of economic planning appears to be the most crucial question in our life, one on which our historical fate depends.

Which economy may be considered as planned? An economy where all its parts are systematically co-ordinated on the basis of a uniform and systematically worked out economic plan.

How should one begin to solve a problem that is unprecedented in its scale as well as in its difficulties? The principles of a solution may be determined only by a *scientific-organizational* approach. The essence of such an approach may be briefly expressed in the following two clauses:

1) Every organized whole is a system of activities developing in a certain environment and in persistent interaction with it. So a society

is a system of human activities in the natural environment and in a process of struggle against its resistances.

2) Each part of an organized system has certain functional relations with the whole. So each branch of social economics, each undertaking and each worker carries out its own particular function in a society.

These are the two main points of the scientific-organizational attitude that every investigation and every construction concerned with the problems of organizational equilibrium and development are necessarily based upon.

Equilibrium is here, of course, primary and development second.

The first question of the organization of the social economy concerns the regularity connecting production and distribution. Considering these as functionally necessary parts of the economic process, and knowing that production provides all the products for distribution, and distribution in its turn serves to support production one can easily set the following condition of equilibrium: *the equilibrium of the social economy is possible when each of its elements get, by distribution, all means that are necessary to fulfil its social productive function.* So consumption means that sufficient support of his normal manpower must be given to the worker; materials, fuel and implements, in a quantity that is proper for the further development of production, must be given to an enterprise etc.

Let us apply the organizational viewpoint to the problem of the correlation between the branches of production. They are functionally interconnected by *chain connexions* some of which give to others the necessary means of production including the means of making the means of consumption; thereby giving the means of the

recovery of labour power to all others. Certainly it is not a simple linear chain: for instance, if metallurgical production gives iron, steel etc., to machine-building production and the other branches of industry manufacturing metals, then it takes itself machines and tools from those same branches. The coal industry supplies fuel to all other branches of industry and takes implements and materials from some of these. Thus a chain connexion is time and again interlaced with reflexive branches, this obviously makes the connexion still closer.

A certain *proportionality* of the branches is a necessary condition of the *equilibrium* of the economic system which directly results from the chain connexion: all branches must be *mutually sufficient* since in the opposite case equilibrium is violated and the de-organization of the whole takes place. There is a uniform chain mechanism in which the first section is the production of basic productive means and the last section is the production of the consumable resources supporting life and the labour energy of a society; in the presence of a certain technology the correlation's of all the sections of such a mechanism must be quite definite.

For the same reasons the objective possibility of the extension of the different economic branches is also connected with proportionality, certainly, because the technology together with the structure of the system as such is not changed. For example, if the production of iron is expanded by 5% then all branches joined by the chain connexion can expand no more than by 5% together, otherwise they will lack consumable iron; but if they expand by less than 5% together a part of the produced iron remains superfluous and unused. Equally, the branches of the economy that produce the means of the production of iron must supply 5% more than the previous quantity, i.e. they must expand themselves by 5%.

Because of such dependence the extension of the economic process on the whole, whether it is spontaneously anarchic or it is organized systematically, is subject to the *law of the leasts* and it is obvious that an extension of the economic whole depends on those of its parts that lag farthest behind. Suppose, for instance, that for a new cycle of production some of its necessary elements may be obtained in a quantity that exceeds its previous quantity only by 2% whereas other elements might increase by 4%, 6%, 9% etc. In that case the expansion of the other branches will only be really successful up to the limit of 2%; should it attempt to go further it turns out to be fruitless or it is replaced by a corresponding delay.

The same hidden supposition forms the basis of Marx's theory of crises. It was Marx who discovered that under the market system of capitalism one section of the social economy — consumption by the labouring masses — can not extend with the same speed as other sections of production: a worker is able to buy using only his wage, but the quantity of employed, and therefore buying, workers increases less rapidly than production increases because of technical progress.

The result is a contradiction between this section and others; because of the lengthy chain connexion between the branches and the lack of general systematic calculation the contradiction remains hidden for a long time and it accumulates until it bursts into crisis.

Now the following question arises. What should the formulation of the task be in the phase of *transition* to the scientific planning of the social economy?

To distribute productive powers one needs in the first place a scientific statistical calculation of the proportions of the different sections of the economic whole that would correspond to its *equilibrium*. If the transition were done in calm circumstances

without a catastrophe in the economy then the calculation is based on the factual relations that had been observed in the industrial system before a revolution. But in the presence of a catastrophe that deeply changes the structure of society, its internal tendencies, and, therefore, the character and sum of its needs as well, the calculation must necessarily be done anew.

Since the purpose of the social economy is the satisfaction of human needs in the first place (and then, of course, their development), the initial point of the calculation lies just in these needs — the last link of chain mechanism to which all others sections must be adapted.

Schematically the way of calculation is the following. There is some quantity of population, namely, some quantity of manpower of a certain degree of qualification plus some disabled elements. Their normal living budgets are clarified on the basis of previous experience, physiology and statistics, and it is established that the recovery of all this manpower, including the training of new workers and the support of disabled elements during a fixed period of production, needs such and such quantities of certain consumable things in total. The production of these things presupposes certain expenditures of certain materials, calculated by the technicians, fuel, implements and other production means; but for its production, in its turn, there are needs for certain other means etc. Summing up gives as a result a chain scheme of the type  $A — B — C — D — E...$  where  $A$  denotes, for example, a production of 100 million tons of coal,  $B$  — production of 10 million tons of cast iron,  $E$  — production of 200 million hectolitres of grain and etc. Elements that may be mutually replaced, for example, different kinds of fuel, must be considered as one and the same item. So a *norm of equilibrium* will be defined that is the initial point for all further scientific and practical constructions.

Then the actual state of available elements must be compared with this norm. If they are more than sufficient to fulfil the scheme it remains only to include in it the calculation of possible and desirable extensions and developments of production.

But when the transition to planned organization is performed after a deep economic catastrophe the actual presence of the conditions of production may turn out to be lower at many parts of the scheme, suppose that its real form is the following:  $0.2A - 0.3B - 0.5C - 0.7D - \dots$ etc.

Then, apparently, one deals with the *reconstruction* of production in the first place. According to the law of the leasts the most constraining role in the process of reconstruction will be played by the branches of production lagging most behind, for example, branch *A* in our scheme. These will be the "prioritized" branches in modern terminology and these are to be intensified in the first place by directing into them labour power and appropriate labour means from the branches that are lagging least behind. So the quantities below the norm must be increased one after another according to their minimality until the norm is achieved along the whole line. It is an order of expedience since, for instance, it would be erroneous try to raise transport to its normal scale at once when its capacity need not be used for a long time because of the weaknesses of other branches of the economy.

Certainly, those cases when a society is forced to put the task of its immediate rescue before the task of the reconstruction of the means of production are exclusions from such a sequence. For instance, the insufficient production of bread, although it is not at the lowest minimum, threatens to entail the near destruction of a part of the labour power of society; or suppose that strategic necessity forces the extension of transport and those branches connected with a war

at any price etc. But it will be a forced *violation* of economic systematicity.

The systematic organization of production may force a resort to barter with other societies, even though these are societies of capitalistic type, until it becomes a world organization. During the period of the reconstruction of an economy undermined by catastrophe, the task may be made easier by barter. But its theoretical i.e. that connected with planning, aspect becomes more complicated. Relative surplus in some branches is needed for barter to have the means of settling accounts, for example, factor *C* must be increased say one and a half times, factor *E* — twice. Then it is obvious that the other factors will be forced to change by the chain connexion. Under extreme devastation it may be impossible to get a relative surplus in some branches; then it is possible to replace it with the temporary sale of some part of the system's unexploited natural resources — its lease, giving up for concession etc., to foreign capital.

A special difficulty in the construction of the economic plan of Soviet Russia consists in the connexion of its uniform government, and almost completely industrial economy with 20 million small peasant farms. This connexion partially has the form of requisition but mainly it has the form of exchange. Apparently it is impossible to include the whole of this mass into the economic plan i.e. to take into account and regulate it completely. But it is impossible as well to consider the mass as something external like a "foreign" state which is a partner in barter; the economy regulated by the state gets from it the most important of vital juices — food-stuffs, fuel to a marked degree and even labour power partially; whereas the peasant's farm is undermined too and needs reconstruction as well, the means necessary must be given to it to support its productivity. Its pressing needs must be taken into account and included in the

system of the general plan within these limits, otherwise all calculations may in fact be destroyed.

We have no need to go further here than the most general considerations of the principles concerned with the methods of the scientific-systematic organization of the economy. But it is evident that the task on the whole, its complexity and difficulty, is completely solvable *tektologically*. Apparently it is solvable *only* tektologically.

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<sup>1</sup>A lecture at the First congress on the Scientific Organization of Labour (January 1921). The lecture is published with some abridgement.



### **3. ON CRITICS OF "TEKTOLOGY"**

"Tektology" has excited very few critical comments up until now. I shall not speak here about the two to three more or less impartial reviewers, but as far as I know, the strictly polemic literature directed against "Tektology" for these last 11 years may be placed on ten if not less pages. However quantity is not the point: many things may be said in a few words. So I must respond to the examples of this literature that are known to me.

Firstly, a part of V.I. Nevsky's paper "Dialectical materialism and the philosophy of dead reaction" (in an addendum to the second edition of the book "Materialism and empiriocriticism", by V. I. Lenin) is devoted to tektology. Three main accusations are advanced in this paper. Here is the first: "Probably A. Bogdanov is the only person who knows what the laws of ingression are; but a reader can not fish out of two parts of his "Tektology" anything more than naked schema that say nothing" (p. 379)<sup>1</sup>.

Should I object? I think that any reader, who has at least looked through the book, is already able to judge how flattering V.I. Nevsky's affirmation of his reader's inability to "fish out" something more than "naked" schema is to him.

Further: "...However, besides these schemes, both books of Tektology contain a numerous multitude of new terms confusing the description of a metaphysical system that is already vague. A. Bogdanov himself who likes to protest against the barbarian terminology of bourgeois science piles up scores of new terms. What are the names that he has and where are these taken from:

copulation and conjugation (terms taken from biology), ingression, egression, disingression and system differentiation; and how many combinations of all these symbols he has!" (pp. 379-380).

"Metaphysical system"! According to the ordinary usage of words in philosophy, it means a system operating beyond the limits of experience and possible verification; according to the Hegelian-dialectic usage of words — a system that is alien to the idea of development and proceeds from something motionless, invariable and absolute. The reader will evaluate for himself the composure or, perhaps, the ignorance of terminology that is needed to give such names to the contribution *the whole* of which is devoted to methods of solving practical and scientific-theoretical problems.

"A numerous multitude of terms"... There are quoted seven terms that is about a half of all the terms really introduced by me. Does V.I. Nevsky believe that it is possible to create a new science of a universal scale, a general methodology of any praxis and theory without using new terms? How may new concepts — so new as V.I. Nevsky himself was unable to understand these and to "fish out" anything from these — be expressed then? There are hundreds and thousands of specific terms in any special science. I have no doubts that many new terms will be worked out in tektology in the process of its development, but its methods will open the possibility of rejecting thousands of the old terms of the different sciences since its task is to find a general thing hidden under a variety of "special" covers.

The third main accusation is "idealism".

What it is based on? It is argued from the fact — it is fearful even to say — that "Tektology" deals with "different *complexes* composed of *elements* of different kinds" (p. 378). But Mach has "complexes"

and "elements" also! But Mach is an idealist according to all decrees! Should the proof be continued?

Alas, a science, that does not decompose studied phenomena into such or other elements and then pass to *combinations* of these, i.e. to complexes of elements, has not existed so far and does not exist now. Chemistry has as its elements, say, the atoms of simple bodies, biology has other elements — say, cells; sociology — human beings, etc. But all sciences call their simplest elements "elements"; combinations of these have many different names: in chemistry — combinations, in biology — organisms, colonies, species, etc., in sociology — groups, classes, etc. Mach has nothing to do with these; he deals with a *special* decomposition of experience into its *sensual elements* and complexes correlating to *these* special elements. If V.I. Nevsky knows a science that has not its own "elements" and their "complexes" let him name it. That would be extremely interesting.

V.I. Nevsky quotes the following thesis from my paper in "Socialism of science"<sup>2</sup>: "Organizing activity is always directed to the creation of *systems* from some parts and elements". Then he notes: "As we see, one can not take a step without Bogdanov's elements"(p. 381). I thought that the thesis quoted simply expressed an immutable fact. But apparently V.I. Nevsky knows of such an organizing activity that dispenses with any elements. That would be very interesting again and V.I. Nevsky has no right to hide such a discovery, he must publish it as promptly as possible!

However, there is yet other evidence of "idealism".

As I point out, organized elements are always activities-resistances. At the same time I do not explain what their "basis" is, whether matter or spirit. It should be noted that the point here is not the matter studied by physics and chemistry; they are only phenomena.

The point in question is matter as a substratum of phenomena, matter as "thing in itself". And when speaking of elements-activities in "Tektology" as I do not speak about matter, it is clear that I mean these to be "spirit" and hide this meaning only to escape responsibility.

In my book I speak about such matter-phenomena that earlier were thought to consist of solid pieces — atoms but now are decomposed by physics into electrical charges and their power fields; I do not speak of matter as thing in itself, or spirit either.

I think that my reader has had time already to understand why it is so. Simply here is no room for matter and spirit. A *science* is restricted by *scientific* limits and "things in themselves" are *philosophical* concepts. Whether I am right in supposing that, besides all else, tektology eliminates philosophy in general — is another question. But it is clear that if tektology is a science then it *is obliged* to study phenomena and their connexion and regularity leaving all else to philosophy. Tektology does not refute these philosophical concepts but there is no room for these in a solution of *its* tasks.

I do not understand who or what prevents V.I. Nevsky or somebody else who wants to say: "But elements-activities hide a thing in itself, that is, matter affecting our sensual bodies and produces the sensations concerned with these activities" — all is as it is supposed. If it gives you something more, and you believe it to be a better thing — please, let it be. However, it simply does not concern tektology as a doctrine of organizational regularities.

That is V.I. Nevsky's critique. P.M. Kerzhentsev's critique is much more concrete. Here is what he wrote about me<sup>3</sup>. "His reactionary character in the scope of organizational problems is illustrated well enough by the following, the most favourite theses of

"organizational science": "the chain is no stronger than its weakest link — the points of least resistance determine the fate of any system as a whole" (see A. Bogdanov's lecture at the I Conference on Scientific Organization of Labour)<sup>4</sup>".

"A. Bogdanov takes this law from mechanics ("the strength of the chain is determined by the weakest of its links") and transfers it entirely to the field of the social sciences proceeding from his unproven theory according to which there exist universal organizational principles that are equally valid in the field of technology as in the field of economics and the fields of other scientific disciplines."

"Thus, arbitrarily applying a law of mechanics to social phenomena, Bogdanov raises one of the most reactionary principles to the status of an immutable law according to which human society *is called* to compete with its most backward, weakest and most undeveloped part. Transferring the doctrine into the political sphere we must, for example, arrange our economical work proceeding from the interests of the most backward peasant farms and subordinate our party work to the wishes of the minimally self-controlled and stable elements of the party etc."

But here is what I wrote on that occasion in my previously unpublished letter to the editorial board of the newspaper "Pravda": "I have stressed in the quotation the words "is called" because it is precisely that which contains the essence of an incredible misunderstanding: a viewpoint *diametrically opposite* to my real one is ascribed to me. Nevertheless I must confess that I do not understand how this misunderstanding may arise. Whether, really, somebody ever considered the proverb "the chain is no stronger than its weakest link" to be reactionary? Is it, really, *a call* even to the whole from the thinnest and the weakest of its parts? The

proverb *states facts* reducing a countless number of facts to a merely figurative generalization. And its application may consist only in "a call" from the thin to the firm and the weak — to the strong *so as the chain would not be broken.*

I use formulae, not proverbs or images; but exact formulae of how facts take place, these can not be "a call" to reduce the facts to the level of the worst. Lybykh discovered the same "law of the minimum" for agronomy: crop capacity depends on the most insufficient factor of all the factors that determine the development of plants. Is it a call for all the factors of crop production to be reduced to the level of the least? Fortunately, nobody from amongst the agronomists understood Lybykh in that way, and his law remains one of the basic tenets of agronomy — it was perfected over time again and has taken the form of Mitscherlich-Boulee's exact formulae. For example, when I point out that the break of an enemy line occurs at the sector of "the least relative resistance" (the least with respect to resisting enemy forces) — does it mean that the army "is called" to reduce the strength of the whole front to the strength of its weakest point?

When I recall that sometimes all our factories worked only half-time because of the lack of lamp-glasses — is it "a call" to preserve such a situation?

During my report to the 1st Conference on the Scientific Organization of Labour that is mentioned by P.M. Kerzhentsev I was asked about those branches of industry that must be considered as "shock" branches, i.e. that must be in the first place in the queue for restoration after devastation. My answer was the following: the relatively maximally undermined and the most backward branches will inevitably delay all others, and, therefore, these are to be

supported with greatest energy. Is it "a call" to reduce the level of all branches to that of the backward ones?

Now I am afraid that I unjustly divert the attention of my reader. Was there, really, a need to refute the comprehension of law of the leasts and the proverb "the chain is no stronger than its weakest link" that P.M. Kerzhentsev has shown? Was it not completely sufficient simply to state it?

Now I pass to the third critic — I. Wainstain, (Tektology and Tactics // Under the Banner of Marxism 1924, N 6-7)<sup>5</sup>.

I must confess that I am in much more awkward situation here. The point is that ... I am ashamed of this confession but ... I did not understand this paper.

It is written in an extraordinary scientific style that rarely may be met unless in seminar lectures given by first year students and that, being insufficiently clear to the Professors themselves, forces them to ask the speaker in perplexity: "What did you want to say in fact?". Certainly, having no right to address that question to the honourable author, I tried intensely to understand. What I was successful in comprehending is reduced approximately to the following.

Tektology is reactionary. Why? Since it prevents the revolutionary tactics of the proletariat. How? In what mode? Because it "gnoseologically leads to the denial of political revolution proclaiming its tektological indifference" (pp. 91-92).

Where? When? How? Where did the honourable author read that? How can tektology lead "gnoseologically" not only to such a disgraceful thing as the "denial of political revolution" but to anything else at all, when tektology denies any "gnoseology" as

scholasticism? Where is the "tektological indifference to revolution enunciated"? It is inconceivable! Or perhaps it is too unpopular...

Then tektology is reactionary because "the tactics resulting from Bogdanov's organizational philosophy are not the tactics of revolution. The tactics resulting from the organizational principles of Bogdanov's philosophy are the creation of a "unity of cognitive methods that breaks the limits of specialization and gives an integral well-composed and harmonious organization of social experience"... Bogdanov thinks that the tactics of the proletariat are the working out of a "world methodology" that must "comprehend human and world activities" (p. 92, *passim*).

Understand, my God! I thought up to now that I knew what the word "tactics" meant. Apparently I was mistaken. I believed that, in accordance with all the dictionaries, tactics are methods of current struggle, for instance: parliamentary tactics, terrorist tactics, military-fighting tactics, etc. I thought that the creation of a world methodology may be a *program*, a vast scientific-cultural program. But it turns out to be tactics competing with strike tactics, partisan tactics, etc.

It is clear that there is a profound difference of principle between me and the honourable author. The reader knows what principles I proceed from. Apparently, the honourable author proceeds in his criticism from the principle that is expressed by folk wisdom in the Russian proverb: "There is an elder in the kitchen garden and an uncle in Kiev ". Nobody disputes this in principle. I shall abstain from a dispute also.



Apparently there is need for a critique of Tektology.

If it must be, then in first place it must answer the question: "Is a universal organizational science possible?" I.e. is it possible to investigate organizational processes scientifically and to state their regularity?

If not, then why is it impossible? This conclusion, would be very sad for humanity, because it deprives it of the hope of organizing life as a whole scientifically, and of any hope that this science could be strictly and exactly grounded.

If yes, then certainly, one may ask whether the laying of the foundations of this science has been carried out well, by me, its initiator.

If it is carried out badly then the critics must show how, really, it may be done better.

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<sup>1</sup>В.И. Невский , "Диалектический материализм и философия мертвой реакции" // В.И. Ленин, Материализм и эмпириокритицизм, 2-ое издание, М. Государственное издательство, 1920, стр. 371 - 384 (V. I. Nevsky, "Dialectical Materialism and the Philosophy of Dead Reaction" // V. I. Lenin, "Materialism and Empiriocriticism", 2 edition, State Publishing House Moscow).

<sup>2</sup>А.А. Богданов, "Социализм науки", М., Пролетарская культура, 1918 (A.A. Bogdanov, "Socialism of Science", Proletarian Culture Publishing House, Moscow).

<sup>3</sup>П.М. Керженцев, Статья в газете "Правда", 1923, № 81 (P. M. Kershentsev, The article in the "Pravda" newspaper, 1923, No. 81).

<sup>4</sup>А.А. Богданов, "Организационные принципы единого хозяйственного плана" (A. A. Bogdanov, "The Organizational Principles of a Uniform Economic Plan" (reproduced as addenda 2, this edition, book one).

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<sup>5</sup>И. Вайнштейн , "Тектология и тактика" // Под знаменем марксизма, 1924, № 6-7, с. 90 - 96 (I. Wainstain, "Tektology and Tactics" // Under the Banner of Marxism, 1924, No. 6 - 7 pp. 90 - 96).

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