REFLECTIONS ON LUDWIG VON BERTALANFFY'S "GENERAL SYSTEM THEORY: FOUNDATIONS, DEVELOPMENT, APPLICATIONS"

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"Something is rotten in the state of Denmark".
W. Shakespeare. Hamlet, Prince of Denmark.

The purpose of this paper is to analyze the basic concepts of General System Theory (GST) as they were described by Ludwig von BERTALANFFY almost 50 years ago in the book "General System Theory: foundations, development, applications" (1968). All excerpts below are from the above mentioned book.

This study follows our previous paper dedicated to the analysis of M. WERTHEIMER's book "Productive thinking" published also a number of decades ago. In that paper (GUBERMAN, WOJTKOWSKI 2001) we highlighted the depth of WERTHEIMER's ideas, and the relevance of the concepts exposed in his book to the field of high-tech computing and the internet. With the same attitude we have undertaken an analysis of L. von BERTALANFFY's book on General System Theory, a key and prominent field of research in the twentieth century.

BERTALANFFY did a masterful job in drawing the attention of the scientific community to important and complicated problems related to the understanding of Nature, however he did not succeed in developing practical solutions to these problems. In this respect, the situation reminds us of EINSTEIN's fate: he formulated the Unified Field Theory but did not succeed in resolving it.

I. Source

"It was the aim of classical physics eventually to resolve natural phenomena into a play of elementary units. This however is opposed by another remarkable aspect. It is necessary to study not only parts and processes in isolation, but also to solve the decisive problems found in the organization and order unifying them, and making the behavior of parts different when studied in isolation or within the whole" (p. 31).

We are forced to deal with complexities, with "wholes" or "systems" (p. 5).

Here are the main notions, which attracted B's attention in the 20s and 30s and which promised (in his view) the resolution of modern scientific and technical problems: the whole, the parts, the units, the complexity, the organization. Earlier, Gestalt psychology had raised similar goals, but with a different point of view. Gestaltists treated the "whole" as a psychological phenomenon, the product of our mind, whereas B. thought of the "whole" as existing independently and therefore tried to create a regular scientific discipline – General Systems Theory. Interestingly, BERTALANFFY understood that "Gestalt psychology showed the existence and primacy of psychological wholes" (p. 31)

Gestalt psychology flourished in times that were very different from those during which General Systems Theory grew. The beginning of the century was the "Silver age" of arts (particularly in painting, poetry and theater). GST's arose during the middle of the century. This was the "hour of triumph" for science (particularly in nuclear physics, electronics and molecular biology). In this context, we can understand BERTALANFFY's choice to look to the exact sciences for solutions to complexity problems, wholeness and so on. He fervently believed as much: "GST is a logico-mathematical science of wholeness" (p. 256)

II. Definitions

Any new science or discipline requires a set of definitions and common terms, and BERTALANFFY was no stranger to such requirements:

> "We postulate a new discipline called General Systems Theory. Its subject matter is the formulation and derivation of those principles, which are valid for "systems" in general" (p. 32).

BERTALANFFY, however, faced many difficulties trying to define the most basic notions of his new discipline. Here are some examples from his book (our remarks are in cursive).

1. GST is a logico-mathematical science of wholeness (p. 256)
2. GST is a general science of organization and wholeness(p. 288).
3. System theory is a broad view (p. VII).
4. New science (p. XVII).
5. System thinking (p. XIX).
6. The GST is scientific exploration of "wholes" and "wholeness", which, not so long ago, were considered to be metaphysical notions. Novel conceptions have developed to deal with them ("wholes" and "wholeness" – S.G), such as dynamical system theory, cybernetics, automata theory, system analysis by set, net, graph theory and others"(p. XX). *But that claim does not fit the reality: none of these disciplines had defined such notions as "whole" and "wholeness".*
7. GST is a general science of "wholeness"(p. 37).
8. Systems philosophy – organismic outlook of the world as a great organization (p.XXI). *That kind of definition leads nowhere.*
9. What is to be defined and described *(?)* as system is not a question with an obvious or trivial answer. It would be readily agreed that a galaxy, a dog, a cell and an atom are real systems, and logic, mathematics and music are conceptual "systems" (p. XXI*). One would agree that the first are "real", and the latter are "conceptual" objects, but one can't agree that they are real systems and conceptual systems because the notion of "systems" is still not defined.*

10. Systems approach (p. 4)
11. We are forced to deal with complexities, with "wholes" or "systems". (p. 5)
12. The general theory of hierarchical order obviously will be a mainstay of GST.
13. Gestalt psychology showed the existence and primacy of psychological wholes. (p. 31)
14. Systems, i.e. complexes of elements standing in interaction (p. 33). *That definition is not acceptable because there is no definition for "complexes of elements*".
15. Systems are "sets of elements standing in interaction." (p. 38)
16. System of elements in mutual interaction (p. 38). *(defining "systems" by "systems").*
17. Organisms are, by definition, organized things.
18. If we are speaking on systems, we mean "wholes" or "unities".

Many of BERTALANFFY's definitions could not serve as such as they rely on other undefined terms (for example, "*complexes* of elements standing in interaction" [14] or "*system* of elements in mutual interaction" (p. 45)). It is the vagueness of these definitions that from the start prevents GST from achieving the very goals it set out to accomplish.

When the definition is non-contradictory ("*sets* of elements standing in interaction", [15]), it is so broad that any arbitrary set of objects in the universe becomes a system. Such definitions single out no objects for investigation. BERTALANFFY made an effort to substitute the definition of "system" by means of another basic notion: "If we are speaking on 'systems', we mean 'wholes' or 'unities'"(11). But "wholes", or "wholeness", or "unities" were also never defined. The attempt to define other basic terms was also inadequate: "Organisms are, by definition, organized things".

BERTALANFFY completely understood the situation: "What is to be defined as system is not a question with an obvious or trivial answer" (p. XX). He admitted the problem and sometimes softened the rank of the GST using such terms as "system thinking" (p. XIX), "systems philosophy" (p. XIX), "systems approach" (p.4).

Because of the difficulties in formulating straight definitions of basic notions BERTALANFFY attempted to define the theory and its basic notions by way of examples. On the first page of his book he claims:

> "An introduction into the field is possible in two ways. One can either accept one of the available models and definitions of system *(?)* and rigorously derive the consequent theory. The other approach – which is followed in present book – is to start from problems as they have arisen in the various sciences, and to develop it in a selection of illustrative examples"(p. XVII).

During the second half of the twentieth century such an approach developed into a technology known as Pattern Recognition. The main idea of Pattern Recognition is as follows. In many fields of science and business decision making is complicated because the variables are many (and sometimes not known), their relationships are not fully understood, and testing of an hypothesis is difficult. In other words, there is a lot of information available but we don't know the laws that determine the outcome, and therefore we don't know how to make the right decision. This is typical in the fields of medicine, geology, economics, and so on. Pattern Recognition technology gives us a chance and some tools to try to improve decision-making through learning based on experience, and using cases with a known outcome. The mandatory demand of that technology is that the representation of all examples must be in the same terms so that they can be compared and so that a general decision rule can be created. Unfortunately, this was not the case in BERTALANFFY's book. The example of "system concept" using geometrical objects (pp. 54 – 55) has no chance to be expressed as a system of differential equations from classical "theory of dynamic systems". If so, how can anyone generalize them?

BERTALANFFY showed a lot of common sense in judging GST. BERTALANFFY used a quotation from ASHBY to describe the state of art in creating the new science.

> "ASHBY has admirably outlined two possible ways or general methods in systems study: Two main lines are readily distinguished. One, already well developed in the hands of von BERTALANFFY and his co-workers, takes the world as we find it, examines the various systems that occur in it – zoological, physiological, and so on – and then draws up statements about the regularities that have been observed to hold. This method is essentially empirical. The second method is to start at the other end. It considers the set of all conceivable systems and then reduces the set to a more reasonable size" (p.94).

It is remarkable that BERTALANFFY didn't deny ASHBY's view of his own work as being non-theoretical and essentially empirical. Moreover, BERTALANFFY admits that his approach "to the mathematically minded will appear naïve and unsystematic". ASHBY himself chooses the second way, that of reducing the set of conceivable systems. He starts with the definition of system but unfortunately he does not succeed. As BERTALANFFY showed, ASHBY's definitions were not general enough. At first, ASHBY recruited areas of science that use the word "system" as a neutral term (non scientific): systems of differential equations; open systems (well defined physical meaning); nervous system; control system; and so on. The point is that none of them deal with "wholeness". Secondly, BERTALANFFY points out the difficulties in a particular area of science and declared a priori that a "system approach" will resolve the problem. These areas mainly represent the life sciences, which are poorly formalized (biology, sociology, economics, psychiatry, etc).

III. Detailed analysis (mathematics, physics, computers, cognition)

BERTALANFFY used a large number of examples to illustrate how a system approach works in science and technology. We will discuss some of the ones which are most familiar to the author.

A. Elementary Mathematics

The basics of system concept are explained in the very beginning of Chapter 3 of BERTALANFFY's book. We will quote the full text of the example (in bold) and follow it with our remarks (in cursive).

"In dealing with complexes of "elements" *(i.e. systems according to the definition)* **three different kinds of distinction may be made …"**

The quotation marks on "elements" and the use of "may be made" instead of a definite "There are" reflect BERTALANFFY's understanding that no precise statements can be declared. This defeats the purpose of defining by example because the example is weak.

"... i.e. 1 according to their number; 2. according to their species; 3. according to the relations of elements. The following simple graphical illustration may clarify this point. (Fig.1) with a and b symbolizing different complexes".

*If we forget for a short while that this example is about GST, we will find a well-known psychological problem. Three similar problems are represented. In each problem two sets of elements are given. The question is: what is the difference between the two sets in each case? The answers are easy and obvious. In the first case two sets differ in the number of elements. In the second case two sets differ in the nature of the elements. In the third one they differ in geometry. It is obvious that the set **a** is the same in all cases and all the differences that we see exist in our perception only.*

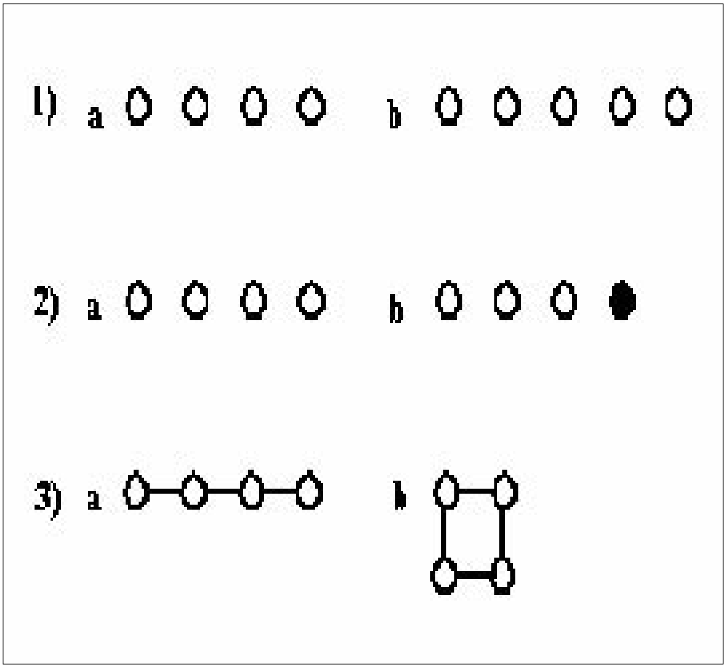

Fig. 1

"In cases 1 and 2 the complex may be understood as the sum of elements considered in isolation"

The use of words "understood" and "considered" suggest that BERTALANFFY was in fact trying to analyze a perception problem. He was investigating the system not in the outside world but rather in our mind. Also it is impossible to understand the meaning of "sum of elements" as the notion of "sum" was not defined in this GST context (e.g. what exactly are we being asked to add, because the result may be different based on the definition)

"In case 3, not only the elements should be known, but also the relations between them."

What is the reason to know something about the system? The answer is simple: because we want to describe the difference between the given two "systems" (complexes of elements).

"Characteristics of the first kind may be called summative, of the second kind constitutive."

A question arises: characteristics of which objects are we talking about: elements or complexes of elements (systems)? The nature of the element is by definition a characteristic of an object. The number is a characteristic of a set of elements (it could not be applied to a single element). The relation between the objects is a characteristic defined for pair of objects. As a result one can't use the proposed classes of characteristics (summative and constitutive) to classify any kind of objects.

"We can also say that summative characteristics of an element are those which are the same within and outside the complex."

As we note above, between the two "summative" characteristics there is only one characteristic of an element – the nature of the element. According to the definition this characteristic is independent of the place or the position of the element because it is a characteristic of the element in principle. So, the last definition becomes a tautology.

"Constitutive characteristics are those which are dependent on specific relations within the complex …"

More precisely, the constitutive characteristics are not dependent on specific relations but they are the relations themselves (according to BERTALANFFY's description above).

"… for understanding such characteristics we therefore must know not only the parts, but also the relations".

This is another tautology, because the constitutive characteristics themselves are the relations.

In the same chapter BERTALANFFY writes 10 lines that deeply and dramatically explain the very essence of the flaws embedded in the GST approach, while at the same time failing to truly understand the implications.

1. BERTALANFFY dismisses the mysticism of "emergent characteristics" – one of the basic statements in system analysis: "The constitutive characteristics are not explainable from the characteristics of isolated parts (*because they are characteristics of different kind of objects: the whole and the parts* – SG). The characteristic of the complex, therefore, compared to those of the elements, appear as 'new' or 'emergent' ". So, according to BERTALANFFY the "emergent" features are simply characteristics of the relationships between the parts.
2. BERTALANFFY admits that systems exist in our mind only: "A system as total of parts with its interrelations has to be conceived of as being composed instantly." Yes! It is true: an instant transformation is impossible in the physical world – it is possible in our minds only.
3. BERTALANFFY uncrowns the "holy banner" of a system approach: "The whole is more then the sum of its parts". BERTALANFFY writes: "If, however, we know the total of parts contained in a system and the relations between them, the behavior of the system may be derived from the behavior of the parts."

With respect to item (3), BERTALANFFY goes on to explain that when the partition is wrong, (e.g. when the "whole" is divided in inappropriate pieces) the "whole" can't be understood or reconstructed from the pieces. But if the "whole" is divided into the right parts, then the "whole" can be reconstructed from these parts appropriately. This transforms the cardinal problem of relationship between the "whole" and the "part" into the problem of appropriate partitioning of a given object. In other words, we come to the problem of finding an adequate language of description. We cannot describe it if we do not understand it, and if we don't understand it how can we know that we are partitioning it properly. For more details we refer to our paper in the *Journal of System Sciences* (1996)

In his book BERTALANFFY repeats dozens of times his belief in the greatness of the GST approach and how it completely reforms modern science. However, he does so without defining the matter of research and any basic notions. But here, after writing the paragraph with cardinally important statements about the "whole" and the "parts", about systems and emergent characteristics, he wrote: "These statements are trivial"!

Returning to the examples represented in Fig.1 it has to be noted that the examples lead to deeper understanding of the problem. The essence of the problem can be found by analyzing the set **a** only. Let us describe the set **a** so that one can reconstruct the image using the following description: "Four small white circles located on a horizontal line at equal distances situated in the center of the page". That description potentially contains all possible oppositions between the set **a** and any other set. To get an opposition one has to change one of the descriptors. For example, changing "four" to "five" gives the difference in the number; converting "white" to "black" creates the difference in the nature of the elements; changing "horizontal line" to "vertexes of rectangle" creates the difference in relations between elements. One can see that there are not three but four kinds of possible distinctions between sets. The forth distinction is the difference in the relation of the set **a** as a whole to the environment. In our case that distinction is represented by the direction of the line (horizontal or vertical) and the position on the page (in the center or at the margin). So, the emergent features (in this case it is the geometrical relations between the elements) don't arise from anything in a mystical process of creating the "whole", but are *chosen from the description generated in our mind by the given image*.

Finally, it has to be mentioned that M. BONGARD (1971) has published a book on pattern recognition, which contained a library of 100 cases similar to the three cases shown in Fig. 1. He questioned if it is possible to develop a program that could find the distinction rule in each "puzzle" (some of them are not trivial to a human eye). Shortly thereafter, with the help of V. MAXIMOV, he succeeded in developing such a program.

B. BERTALANFFY Communication and computers

BERTALANFFY's book contains a number of references to the field of communication and computer science. Some of them are naive and don't support the author's idea, as we will note through the following examples.

1. "The general notion in communication theory is that of information" (p. 41). The fact is that the definition of "quantity of information" exists, (it was introduced by C. SCHENNON), but yet there is no scientific definition of "information".

2. "Examples can easily be given where the flow of information is opposite to the flow of energy, or where information is transmitted without a flow of energy or matter. The first is the case in a telegraph cable, where a direct current is flowing in one direction, but information, a message, can be sent in either direction by interrupting the current in at one point and recording the interruption in another" (p. 42). It is not correct to think that in the cable the current moves is only in one direction – from the battery to the far end. It is a fundamental law of electricity that the same amount of current that goes from the buttery to one wire comes back through the returning wire. That is why the line has two wires.

3."For the second case (when information is transmitted without a flow of energy or matter), think of the photoelectric door openers: the shadow, the cutting off of light energy, informs the photocell that somebody is entering" (p. 42). Of course, the "mystical" communication without energy and matter don't exist (at least in science). The point is that the absence of the light in the photocell is a signal only when that event is followed with a period of presence of light, which, unfortunately, demands energy.

The next reference to the communication field concerns the measurement of information. To represent the idea of the "bit" as a unit for measuring information, BERTALANFFY writes:

> "Take the game of Twenty Questions, where we are supposed to find out an object by receiving simple 'yes' or 'no' answers to our questions. The amount of information conveyed in one answer is a decision *(!)* between two alternatives, such as animal or non-animal. With two

questions *(?)* it is possible to decide for one out of four possibilities. Thus, the logarithm at the base 2 of the possible decisions *('the number of possible decisions' will be correct because it is impossible to calculate the logarithm of decisions. – SG)* can be used as a measure of information" (p. 42).

Let's examine this from a different perspective.

Let us suppose we have eight golden coins that look identical. Seven of them are really identical but one coin is lighter then others. The question is: if one has a simple scale, what will be the minimum number of weighings to find the false coin. The correct answer is three. First, compare the weight of any four coins and the rest four coins. Second, use the lightest set of four, divide it in two even parts and put them on the scale. Finally, take the lightest pair of coins and compare them. The false coin was found with three measurements.

In our classical example it is defined that one can ask only one question, "Which set of coins is heavier?", and a tool is given that is sufficient to answer that particular question only. This means that the answer to the problem ("three weightings") doesn't depend on the skill of the questioner and therefore all the necessary information is provided in the statement of the problem. Compare this situation to that presented by BERTALANFFY in his "twenty questions" example. There, the questions are not predefined. Accordingly, the result of the game (i.e. the number of questions used to get the answer) depends on the skill (or the luck) of the questioner and therefore one cannot be sure that no other participant will find a shorter sequence of questions to reach the answer. Therefore the number of questions cannot serve as a measure of information.

Our classical example tells us that in order to get to the goal in the shortest way it is necessary to divide the set we questioned in two even parts. That is why 2 was chosen as the base of the logarithm in the definition of the "bit". As a matter of fact, in the "Twenty questions" game, the questions never divide the set that exists at a particular step of the game into two even parts. This means that the answer to such a question does not contain one "bit" of information. It is true that in the "Twenty questions" game a good question is one that divides the set of potential objects into two approximately even parts. The extent to which this can be accomplished is however a function of the skills of the questioner.

IV. The big mystery

BERTALANFFY's book provides extensive examples intended to support the creation of this new physico-mathematical science, GST. In the middle of that ocean we see an island: a completely different approach is presented. BERTALANFFY writes 10 lines that deeply and dramatically explain the essence of GST in a way that is completely different from that described elsewhere in the book.

1. BERTALANFFY dismisses the mysticism of "emergent characteristics" – one of the basic statements in system analysis – with the following couple of sentences:

"The constitutive characteristics are not explainable from the characteristics of isolated parts *(because they are characteristics of different kinds of objects: the whole and the parts – SG)*. The characteristic of the complex, therefore, compared to those of the elements, appear as 'new' or 'emergent'".

So, according to BERTALANFFY, the "emergent" features are simply characteristics of the relationships between the parts.

2. BERTALANFFY admits that systems exist in our mind only: "A system as a total of parts with its interrelations has to be conceived of as being composed instantly." Yes! It is true: an instant transformation is impossible in the physical world – it is possible in our minds only.

3. BERTALANFFY uncrowns the holy banner of the systems approach: "The whole is more than the sum of its parts". But he also remarks: "If, however, we know the total of the parts contained in a system and the relations between them, the behavior of the system may be derived from the behavior of the parts."

4. When the partitions are wrong, however, (i.e. when the "whole" is divided into inappropriate pieces) the "whole" can not be understood and reconstructed from its parts. But if the "whole" is correctly divided, then it can be reconstructed appropriately. This transforms the cardinal problem of relationship between the whole and the part into the problem of choosing the appropriate partitioning of a given object. In other words, BERTALANFFY finally comes to the problem of finding an adequate language of description, a key problem that GST does not address and which constitutes the fundamental flaw of this discipline as it is applied to any but the most trivial examples.

5. BERTALANFFY explicitly admits that only the "Gestalt psychology showed the existence and primacy of psychological wholes" (p. 31).

Then the biggest surprise follows. In his book BERTALANFFY expounds dozens of times on the merits of GST and its potential to completely reform the modern science – while skirting on the issue of defining any basic notions and underpinnings. But here, in this island of text where he finally writes cardinally important statements about the "whole" and the "parts", and about systems and emergent characteristics, he opines: *"These statements are trivial"!*

V. The cause of success of GST

Despite all the difficulties in defining the subject of GST and its basic notions, the "system movement" has spread around the world and became an important part of the scientific life in twentieth century. What is the cause of this phenomenon? Our thoughts on this are as follows.

1. There is a practically infinite number of phenomena of key import to mankind but very complicated and for now largely unsolved: in biology, sociology, geology, economics, culture, politics, war, cosmology and in science itself. It is a real challenge and a powerful stimulus for a creative mind to find targeted solutions or perhaps a general solution applicable to a broad class of problems. L. von BERTALANFFY creates an environment that promotes the will to work on complicated problems. It is no wonder that many talented scientists have responded to that call.

Over time, new and differing constructions of GST have surfaced, but none of them succeeded by any practical measure. The reason has generally been the same:

authors have attempted to formulate GST as a solid physical-like or mathematical-like science. This type of framework supposes that any dependence on our consciousness cannot be accepted. Herein lies the problem because the notion of "whole" is a product of our mind.

2. From the very beginning BERTALANFFY tried to penetrate many established scientific areas, particularly poorly formalized areas (such as biology, medicine, psychology, sociology) as well as developing branches of science and technology (cybernetics, computers) that were not yet on a solid scientific grounding.

Scientists, by nature, want to represent their work in a frame of a solid scientific theory, supported by a mathematical base. The GST has provided its practitioners some theoretical framework that emphasizes the complexity of the problem, offers a set of seemingly scientific terms, mathematical formulas and notions, and links them to fashionable topics such as cybernetics, computers, game theory, etc. However, it terms of actually solving practical problems in a measurable way, very little can be shown for this effort. We take this as an indication of the overall weakness of the GST framework.

3. The GST community has historically been favorable to nontraditional hypothesis, theories and approaches. Innovative scientific papers which could not find a forum among established professionals and publications, often were welcomed in the GST community.

It is a very symptomatic fact that 100% of the examples of systems in BERTALANFFY's book are natural objects – objects that are not constructed by humans. The reason is that in human creations the structure of the object, the parts constituting the object (the "whole") are known. So, there is no question how to describe the object, e.g. which parts the object consists of. This means that in these cases there is no "system" problem. BERTALANFFY understood this very well. From that point of view, it also follows that the complexity is not a necessary attribute of a "system". The "system" can be simple (for example a simple drawing) but still give rise to the problem of partition. The proper definition of a "system" in GST is so broad that it covers any set of things in the universe. On this basis alone it is not acceptable in a physical theory. But as soon as one accepts the point of view on "systems" as a psychological problem, a Gestalt problem particularly, the unlimited definition of that notion becomes legitimate because then a "system" is a product of our mind and we are free to investigate any set as a "system".

VI. 50 years later

How does GST look today?

1. The number of definitions multiplies with each new published paper. Everyone proposes new definitions. To us, this demonstrates that everyone understands the necessity of definitions and no one is satisfied with any of previously proposed ones. Consider the following examples taken from a single book on the subject (*Proceedings of Third European Congress on Systems Science*, 1996).

"Set of communicating components according one and only one type of communication " (p. 91).

"A set of actions from a source on a sink represented by a messenger" (p. 427).

"This system is defined from a set S of the internal states, a set I of the inputs an from application F of the cartesian product of S x I in S" (p. 775).

"Usually, we use the word Holistic in an abstract meaning, which says little or often nothing" (p. 59).

This is just the tip of the iceberg. As a matter of fact, mostly each definition is formulated simply to connect the content of the particular paper to the word "system".

Here is a prominent example of devaluation of the system theory notions: "From the systemic way of knowing … it's possible recognizing concepts as singularity, individuality, variety, dynamism, evolution, hierarchy, patterns, order-disorder, entropy and **as many terms of our systemic approach we like to use**" (p.58). O, sancta simplicita!

At the same time, the quality of many papers is good – a lot of interesting and fresh ideas from all around the science.

2. Many authors express their dissatisfaction on the state of art and admit that GST is still in the early stages.

"The debate on GST that evolved in the last few years shows the development of different points of view and opinions about the definition of system" (p. 348).

"The systemic view of the 1950s-1970s may not help us much in the 1990s, for the former may be more introductory than substantively revolutionary" (p. 884).

None of "BERTALANFFY's principles" are mentioned.

3. The idea that systems are products of our mind, and that the system problem is a problem of adequate description was raised even in B's writing in the 60s. "Matter and mind are getting closer and closer, language and objects may find their previous unity. I think that is a systemic goal we are going to achieve" (p. 59). However, as of today, it is still in discussion.

4. GST forums still attract not only interesting, talented and serious works, but also superficial papers that would normally be rejected by professional magazines for fair reasons. We will mention one example from the same volume. The paper contained a full page of images to illustrate the power of a new kind of neuronal network (synergetic computer). On the first figure 10 portraits in gray were shown. Five more images represented different parts of one of the portraits (marked G). The claim was: our software can recognize faces from fragments. This result is trivial because to perform the search the software uses the fragment of the same image that is stored. Any substantial part of an image is unique, i.e. has a unique distribution of black and white pixels. Therefore it is only a matter of time to find the appropriate image in the database. This way any image can be identified using its part. The real problem is to identify a portrait in the database using a different picture of the same person. The paper goes on to state: our software recognizes deformed faces. The corresponding figure contains three portraits (from the ten mentioned above) and three rectangular grids slightly deformed: The grids show how the images were transformed. Two of them were deformed substantially, and one slightly. It turned out (by chance, of course) that the target image was the least destroyed one.

It is appropriate to mention that the idea that the problems of recognition can be solved by developing new sophisticated algorithms died long ago. The practice shows that most recognizers produce the same results if applied to the same data. The only way to improve the results substantially is to change the description of the objects. This point binds pattern recognition to the systems problems.

5. The issue of complexity was one of the main concerns of GST and still is. Let us describe the problem in plain words. The words "complex system" mean that one can't predict the behavior of the system well enough. One cause of that could be the big number of parts in the system (for example, following BERTALANFFY, the "three-body problem"). We know the laws of interaction between the parts, but we didn't find an analytical solution, and the computations on the computer are consuming and expensive. Thais case is not interesting for GST. GST concentrates on systems with descriptions that have failed to consider the relations between the parts. The idea is that taking in consideration the relations will resolve the problem, i.e. one will be able to predict the behavior of the system. This means that the description of the system has to be changed: a set of new parameters has to be involved. That approach to resolving the problem embeds a potential for failure: the partition of the system could be wrong. In that case we will find no adequate rules of interactions between the parts. This is the most common situation in the investigation of complex systems: the existing division of the system into parts is not adequate. From personal experience we find that the resolution of many complex problems can often be found only after a new description of the systems is introduced. We have found this in the fields of oil exploration, earthquake location, speech compression, and handwriting recognition. The *Institute of Complexity* in Santa Fe (Arizona, USA) established early on an ambitious agenda to investigate key problems in culture, economy, ecology, etc. However, little has come of these efforts because the leading idea was to use non-linear equations and supercomputers and apply them to existing descriptions of these systems. Of course, if the descriptions are inadequate, incomplete, or faulty, the problems are not solvable in any framework. Unfortunately, the question of "do we have the right description of the problem" is not raised often enough.

VI. Conclusion

In his work Ludwig von BERTALANFFY continued the line of investigation started at the beginning of the century by Gestalt psychology. The issue was then, and is today, the relations between the "whole" and the "parts". That issue has a long history, dating back to the times of ARISTOTLE. The Gestalt approach frames the problem in a psychological context, assuming that the "whole" and the "parts" are products of our mind, our way to perceive the world. BERTALANFFY's intention was to create a mathematical science of "wholeness", which does not depend on our mind as all precise sciences require. Unfortunately, he did not succeed in his task. His fate is in many ways similar to that of EINSTEIN: he formulated the Unified Field Theory but did not succeed in resolving it. Just as EINSTEIN did not have the right tools, framework, and foundation to succeed in this task, BERTALANFFY also succumbed to trying to build on a very weak foundation.

The fact is that BERTALANFFY saw the approach, continuing the Gestalt psychology's line, which treated the "whole" and "parts" as products of our mind. He wrote short but consistent statements that filled the new wine-skin of GST with new wine, but only a drop or two. It is a mystery why he rejected notions that could have helped him build a better foundation for his work. In the author's personal experience this was the second mystery of science which happened during the second half of the XX century. The first took place in the German atomic project during World War II. German physicists and chemists, famous for their scrupulosity and precision, failed to measure the correct diffusion length of neutrons in pure graphite. They calculated the length to be equal to 35 cm though the correct answer is 70 cm. It meant that the absorption of neutrons in graphite was too large. As a result the graphite pile approach, the quickest way to get test a chain reaction, was rejected.

Will these mysteries be ever resolved in the future?

Summary

In his work Ludwig von BERTALANFFY continued the line of investigation started at the beginning of the century by Gestalt psychology. The issue was then, and is today, the relations between the "whole" and the "parts". The Gestalt approach frames the problem in a psychological context, assuming that the "whole" and the "parts" are products of our mind. BERTALANFFY's intention was to create a mathematical science of "wholeness", which does not depend on our mind as all precise sciences require. This paper discusses the relations between these two approaches.

Zusammenfassung

Ludwig von BERTALANFFY setzte in seiner Arbeit die Forschungslinie fort, wie sie Anfang des 20. Jahrhunderts von der Gestaltpsychologie begründet wurde. Im Mittelpunkt der Untersuchungen standen damals und stehen heute das „Ganze“ und die „Teile“. Der gestalttheoretische Zugang betrachtet das Problem unter einem psychologischen Gesichtspunkt, mit der Annahme, daß das „Ganze“ und die „Teile“ Produkte unseres Geistes sind. BERTALANFFYs Absicht war es, eine mathematisch begründete Lehre der „Ganzheit“ zu finden, die, wie jede exakte Wissenschaft, nicht von unserer Geistestätigkeit abhängig ist. In dieser Arbeit wird die Beziehung dieser beiden wissenschaftlichen Zugänge untersucht.

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